PRESENT AND POTENTIAL TIMBER RESOURCES

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PRESENT AND POTENTIAL TIMBER RESOURCES

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The country's forest resource consists of two fundamental elements, namely, the forest land as such, which is treated in the section on "Forest Land the Basic Resource," and the forest growth which that land bears. The amount, character, geographic distribution, ownership, economic availability, rate of cut or destruction, and rate of growth, of this stand of timber are of the utmost importance, because upon them largely depend the assurance of meeting economically, amply, and permanently our needs for timber and timber products and for other forest benefits. They determine the degree to which the forest resource, land and timber, is approaching its potential contribution to the Nation's economic welfare. They influence the determination of whether and what positive measures are needed, nationally and regionally, both by the private owner and the public, to put the forests on a satisfactory basis. It is the purpose of this discussion to present the best information available as to the timber stands on the 495 million acres classed as commercial forest land.

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[1] Valuable contributions in analysis and interpretation of the growth data presented in this section were made by E. N. Munns. C. E. Behre, and W. N. Sparhawk. Acknowledgment is also due to R. V. Reynolds for assistance in the development of the data on forest drain, and to W. D. Brush for cooperation in the compilation of the data throughout this section.

PRESENT TIMBER SUPPLIES

VOLUME AND DISTRIBUTION

SAW TIMBER

Saw timber deserves first attention. Of the broad classes of forest growth, saw timber is in greatest demand, being required for lumber, crossties, veneer, and similar sawed or sliced products. The long periods required in its production, moreover, aggravate the problems of those attempting to apply systematic forest land management, particularly in the case of private owners.

The present estimate of saw timber on commercial forest land in the United States is 1,668 billion board feet (board foot estimates

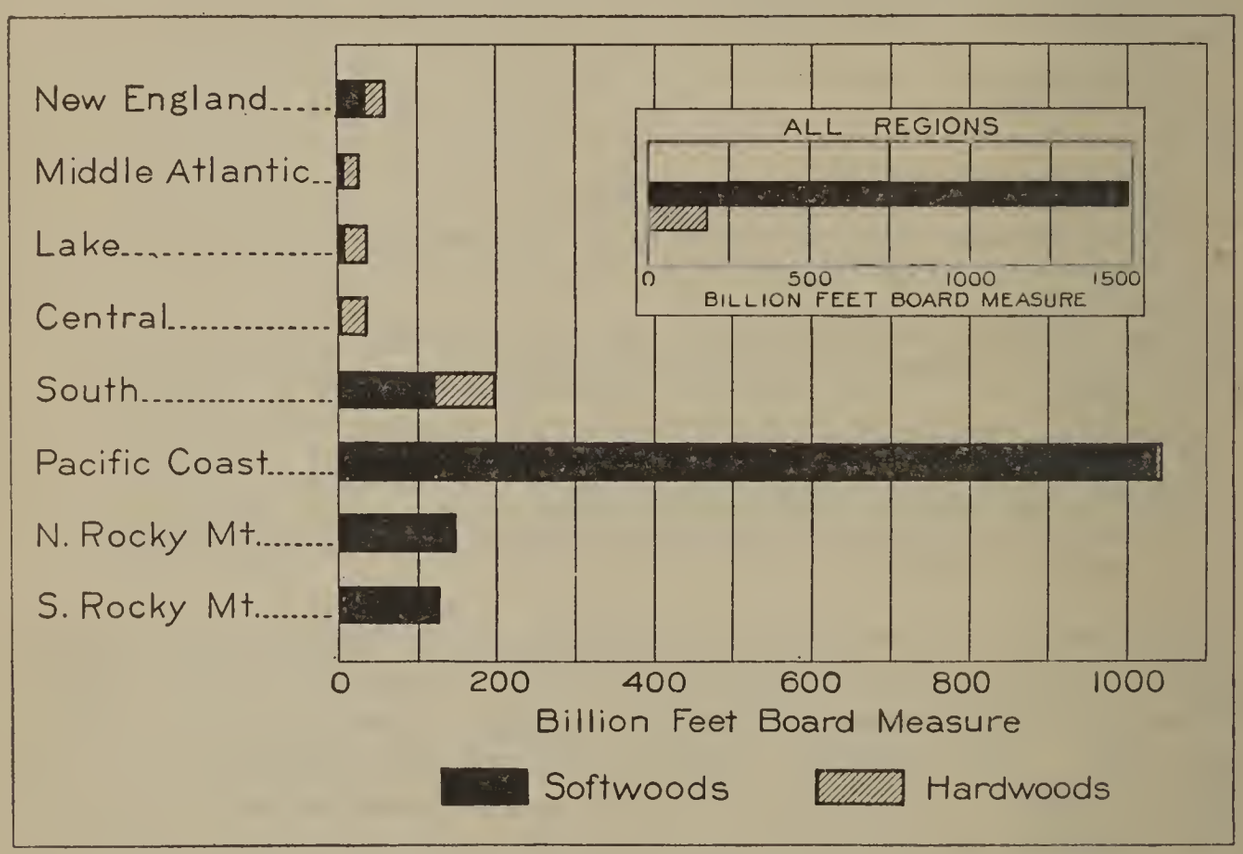

FIGURE 1.—Softwood and hardwood saw-timber stands of the United States by regions.

based on lumber tally). (Table 1 and figs. 1, 2, 3, and 4.) Of this, 1,346 billion board feet, or 80 percent, is old growth and represents the remainder of the original stands that have been crudely estimated as at least 5,200 billion board feet. The original forest growth on possibly 150 million acres was destroyed in clearing the land for agriculture in the early days. The volume of old growth cut for lumber since those early days has been estimated at 1,650 billion board feet. Cuttings for other purposes and continuous losses through fire, disease, and insects have taken the rest. Old growth—characteristically two or three hundred, often several hundred years old—still dominates the lumber market, but its days are numbered. It is doubtful that man will ever grow, as Nature has grown, extensive crops of fully mature trees, such as will furnish the strong and durable timbers of large dimensions and the high proportion of clear products that have commanded the best markets in the past and given lumber its high rank as a valuable construction material.

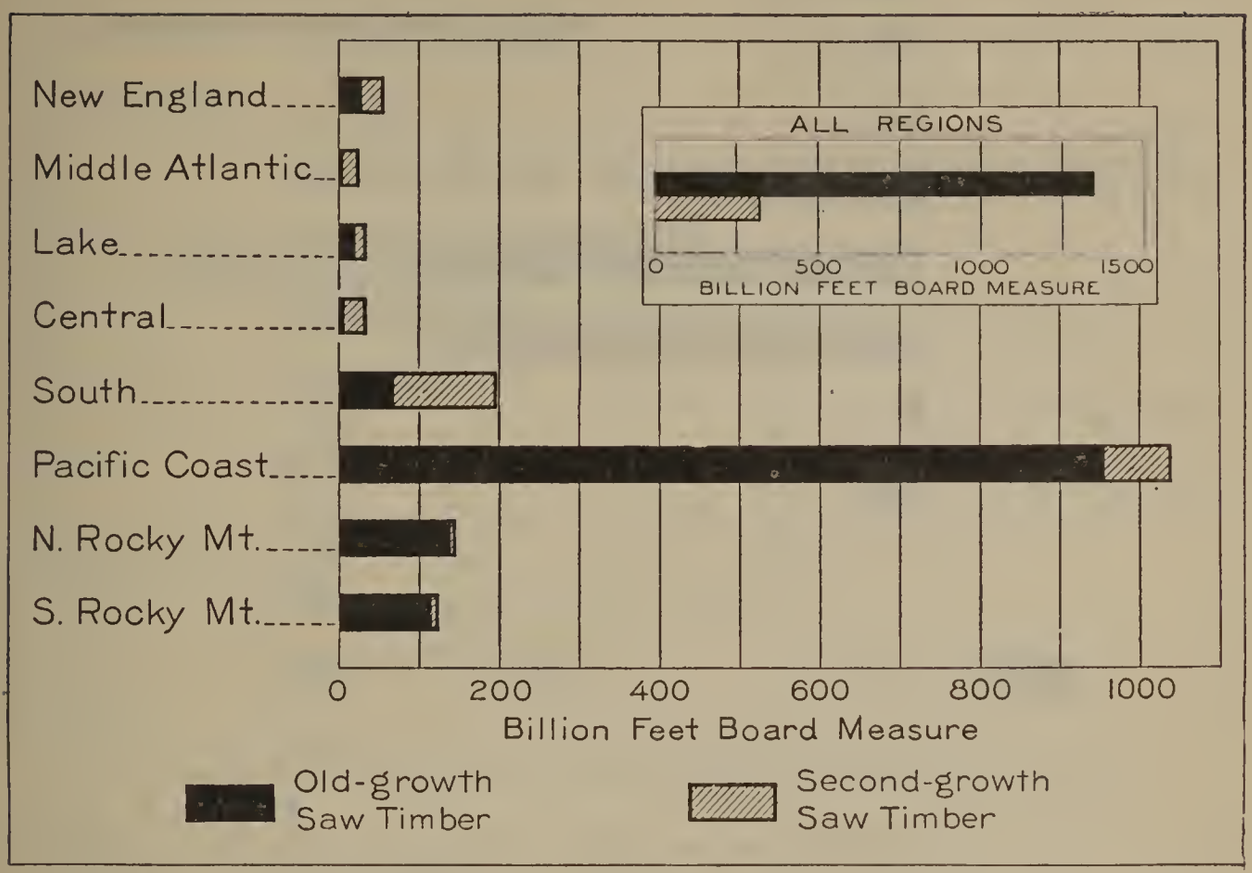

FIGURE 2.—Old-growth and second-growth saw-timber stands of the United States by regions.

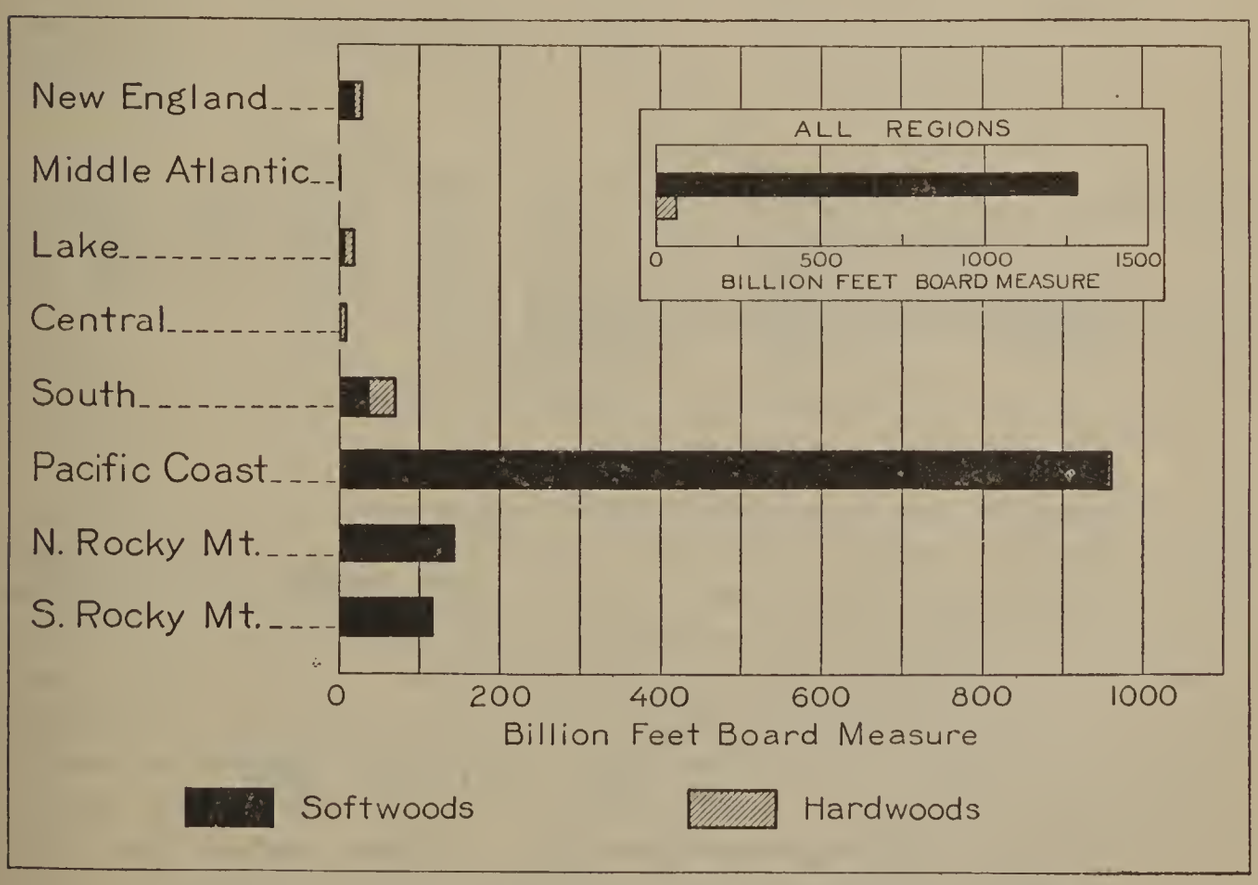

FIGURE 3.—Old-growth saw-timber stand of the United States by regions.

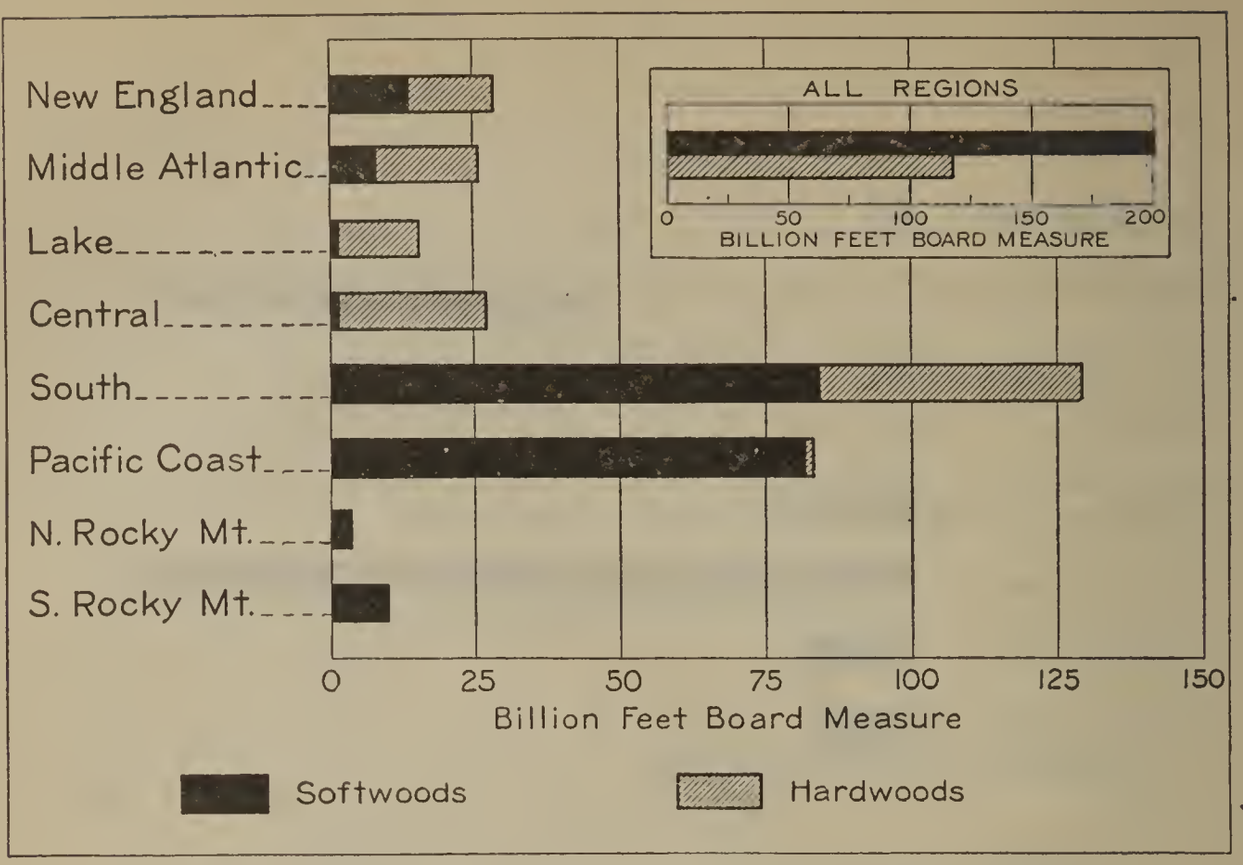

FIGURE 4.—Second-growth saw-timber stand of the United States by regions.

TABLE 1.—*Stand of saw-timber in the United States, by character of growth and region*

[In million feet board measure]

Region	Total		Softwoods			Hardwoods		
			Total	Old growth	Second growth	Total	Old growth	Second growth
		Per-cent						
New England	57,875	3	32,811	18,977	13,834	25,064	10,295	14,769
Middle Atlantic	26,150	2	8,245	144	8,101	17,905	195	17,710
Lake	35,887	2	9,193	7,656	1,537	26,694	13,327	13,367
Central	34,622	2	2,900	1,146	1,754	31,722	6,332	25,390
South	199,297	12	121,449	37,312	84,137	77,848	32,866	44,982
Pacific Coast	1,041,628	62	1,038,909	957,208	81,701	2,719	1,421	1,298
North Rocky Mountain	146,388	9	146,388	142.680	3,708			
South Rocky Mountain	125,956	8	125,955	116,215	9,740	1	1	
Total	1,667,803	100	1,485,850	1,281,338	204,512	181,953	64,437	117,516

The volume of second-growth saw timber is far too small for a desirable balance with old growth, cordwood, and smaller growth, considering the large proportion of the total forest area that has been cut over. This is in part because of the practice in important regions like the South, of cutting the second-growth trees as soon as they reach merchantable size, but before they have reached physical or economic maturity. It is also due to the all too prevalent lack of interest in maintaining the continued productivity of the land following cutting, whether of old growth or second growth. A third cause is fire, which prevents or delays restocking on millions of acres of cut-over lands and retards growth even after a new stand is established.

The steady progress of the lumber industry from the Northeast and Lake States to the South and in turn to the West is reflected in the

heavy depletion of the eastern saw-timber stands and the location of the bulk of the remaining saw timber in the West. Thus, the New England, Middle Atlantic, Central, and Lake regions with 35 percent of the commercial forest land contain only 9 percent of the saw timber,

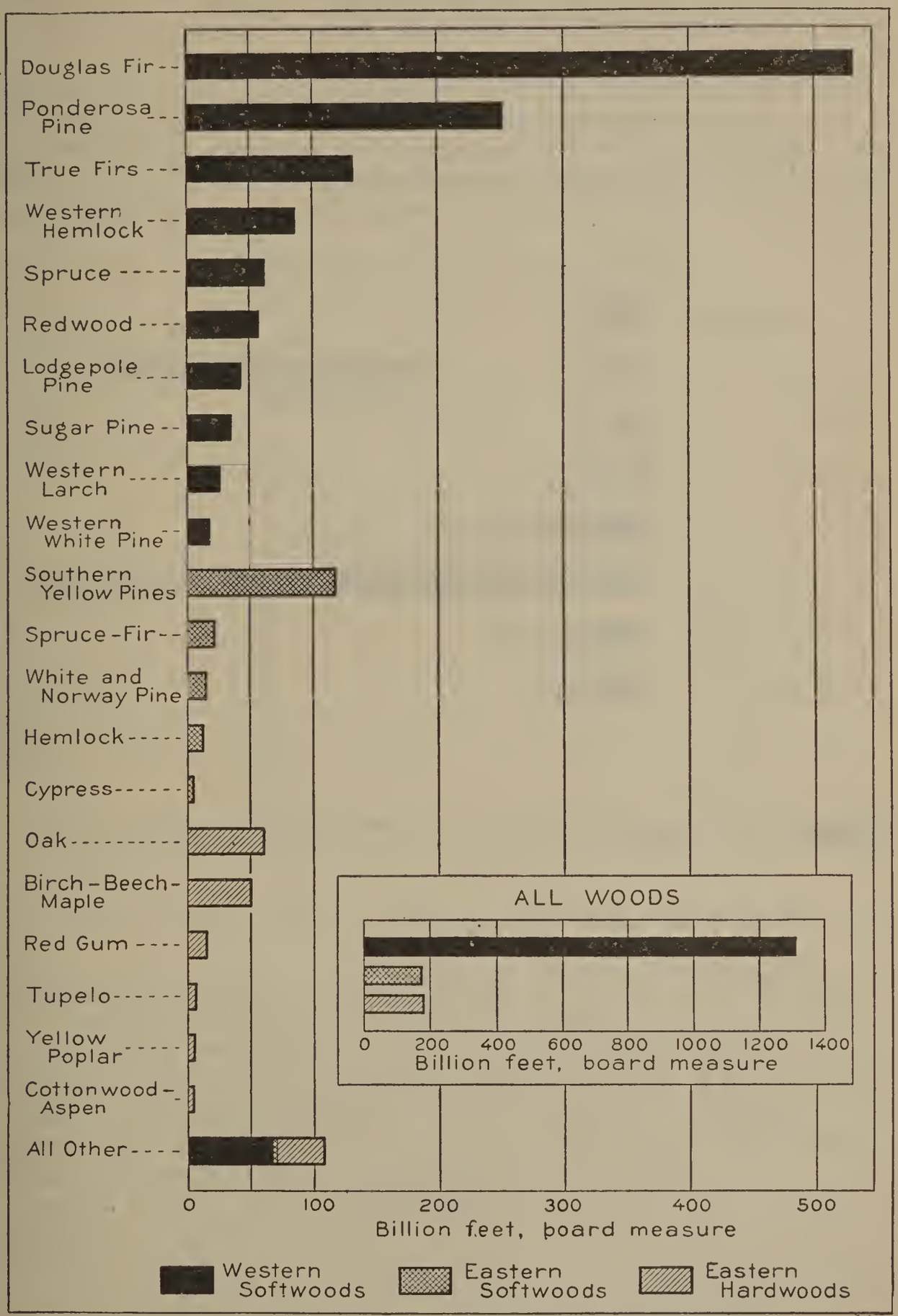

FIGURE 5.—Saw-timber stand of the United States by important woods.

the South with 39 percent of the area contains but 12 percent, while the West with 26 percent of the area contains 79 percent of the saw timber, and nine tenths of the old growth. The Pacific Coast region alone has 13 percent of the area and 62 percent of the saw timber.

In other words, the one great remaining reservoir of saw timber, and that softwood, is the Pacific Coast region. For years the New England, Middle Atlantic, Central, and Lake regions have contributed relatively little to the softwood-lumber production of the country; and the South, because of waning supplies, is losing the commanding position which it has held for 20 or 30 years. This large Pacific Coast supply of saw timber seems capable of being an important asset in helping to tide over the interval which apparently must elapse before the East can be organized on a more satisfactory forest-producing basis. Highly developed mass production methods of lumber manufacture and low-cost water transportation render much of this timber economically available to eastern consuming centers, and apparently

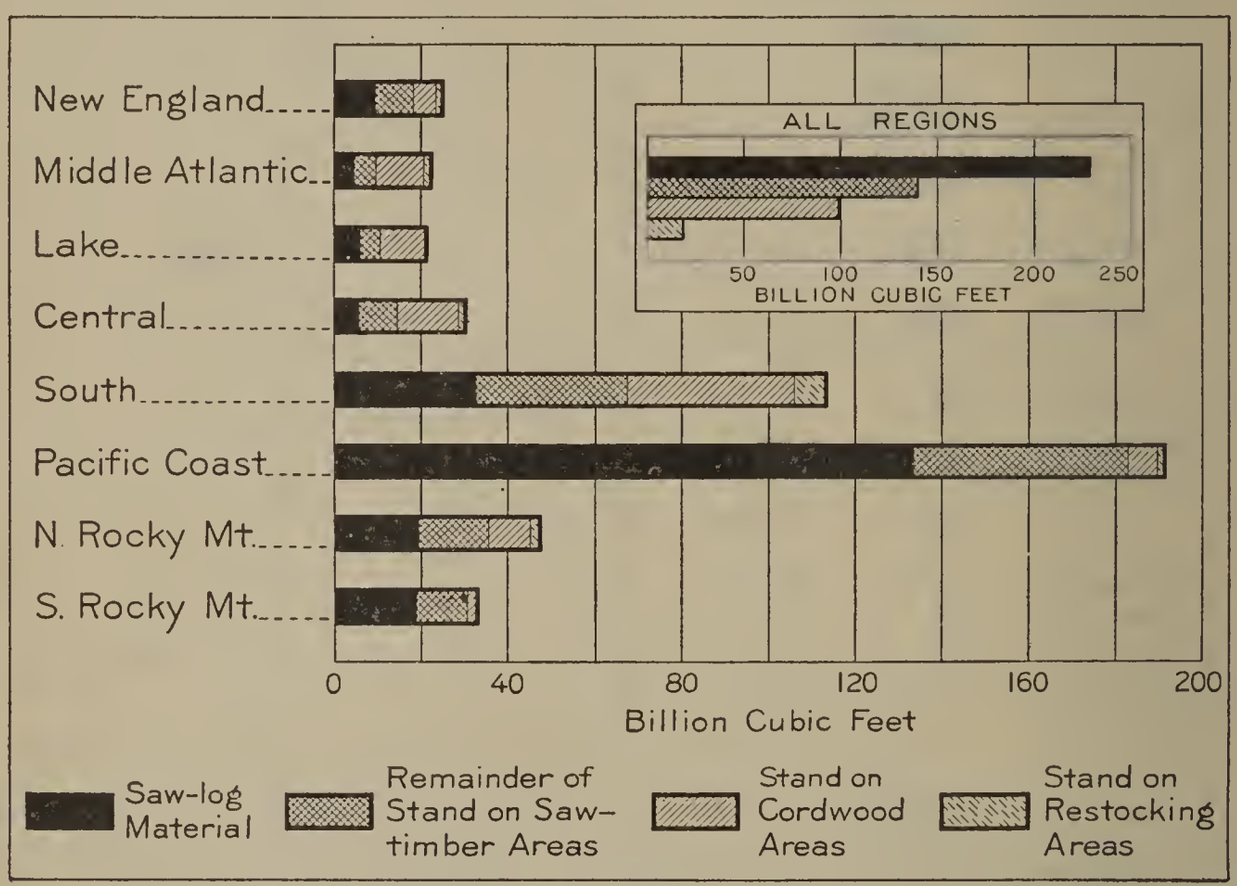

FIGURE 6.—Total stand (cubic feet) in the United States including saw-timber areas, cordwood areas, and restocking areas, by regions.

should facilitate a period of reduced cutting and of rehabilitation of the depleted eastern softwood forests. On the other hand, owing to circumstances which need not be discussed here, the pressure to liquidate is so great upon private owners in the Pacific Coast region that stumpage is being thrown on the market with little regard to sustained yield requirements, and with the effect of further depressing market conditions, and for the time being, rendering forestry measures less attractive for the private forest-land owners in other regions.

Table 2 and figure 5 illustrate the distribution of the saw timber by hardwoods and softwoods, and by important species, for eastern and western United States. Douglas fir, with 530 billion board feet, 80 percent of which is in Washington and Oregon, is far in the lead. Ponderosa pine, widely distributed through the West, is second with 252 billion. These two species comprise half the softwood saw timber of the entire country.

TABLE 2.—*Stand of saw timber in the United States, by region and species*

[In million feet board measure]

Kind of wood	Total	New England	Middle Atlantic	Lake	Central	South	Pacific Coast	North Rocky Mountain	South Rocky Mountain
Eastern hardwoods:									
Oak	60,753	1,048	4,783	6,017	16,315	32,590			
Birch, beech, and maple	49,943	20,973	8,555	13,459	4,401	2,555			
Red gum	15,488		71		874	14,543			
Tupelo	6,342				116	6,226			
Yellow poplar	5,172	18	203		1,635	3,316			
Cottonwood and aspen	4,437	2,022	20	887	222	1,286			
Others	37,098	1,003	4,273	6,331	8,159	17,332			
Total	179,233	25,064	17,905	26,694	31,722	77,848			
Eastern softwoods:									
Southern yellow pine	118,132		597		1,433	116,102			
Spruce and fir	21,533	18,720	1,564	843	175	231			
White and Norway pine	14,672	8,390	3,530	2,392	159	201			
Hemlock	12,198	3,675	2,462	4,612	765	684			
Cypress	4,140				263	3,877			
Others	3,923	2,026	92	1,346	105	354			
Total	174,598	32,811	8,245	9,193	2,900	121,449			
Western hardwoods	2,720						2,719		1
Western softwoods:									
Douglas fir	530,197						484,138	33,933	12,126
Ponderosa pine	251,560						178,051	31,938	41,571
True fir	131,933						109,196	14,594	8,143
Western hemlock	86,464						86,464		
Spruce	61,582						12,782	12,513	36,287
Redwood	57,233						57,233		
Lodgepole pine	43,276						2,143	14,556	26,577
Sugar pine	35,516						35,516		
Western larch	26,118						8,043	18,075	
Western white pine	19,508						3,944	15,564	
Others	67,865						61,399	5,215	1,251
Total	1,311,252						1,038,909	146,388	125,955
All species	1,667,803	57,875	26,150	35,887	34,622	199,297	1,041,628	146,388	125,956

The true firs of the West comprise 132 billion, and then come the southern yellow pines, including principally longleaf, loblolly, shortleaf, and slash pine, with 118 billion. The once large supply of northern white pine in the Lake States, highly prized as a standard wood for millwork, boxes and crates, novelties, and patterns, has been so depleted that it now comprises less than 1 percent of the country's softwood. Western white pine and sugar pine, however, are substantially similar to the white pine of the East in technical and mechanical characteristics, but the supply of these is also small.

The hardwoods are practically confined to the East. They constitute but one tenth of the country's saw-timber stand, and yet contribute annually a quarter of the saw-timber cut. Unlike the softwood stands, in which second growth makes up but one seventh of the total, hardwood stands comprise nearly twice as much second growth as old growth. The South is the most important hardwood region with 43 percent of the total hardwood stand for the country.

We are approaching measurably near the end of our ready-grown mature hardwoods. Depletion of the hardwood supply has not only progressed further than that of softwoods, but this progress is par-

ticularly marked among the more valuable woods (table 2 and fig. 5). Three of the most valuable hardwoods—hickory, ash, and yellow poplar—together have an estimated stand of less than 15 billion.

CORDWOOD

The total volume of all classes of cordwood is estimated to be 2,382 million cords. This total includes trees too small for saw logs but large enough for cordwood use, regardless of whether it is cut for cordwood or held for saw timber. It is made up of (1) the material on the cordwood areas, estimated at 1,102 million cords, and (2) the material below saw-timber size on saw-timber areas, estimated at 1,280 million cords. The latter, in turn, is made up of 794 million cords of small trees and 486 million cords of tops and limbs (tops only in softwoods) of saw-timber trees.

TABLE 3.—*Stand of cordwood on cordwood and saw-timber areas of the United States, by regions*

[In thousands of cords]

Region	Total		Cordwood areas			Saw-timber areas		
			Total	Softwood	Hardwood	Total	Softwood	Hardwood
		Per cent						
New England	149,913	6	56,801	14,555	42,246	93,112	20,238	72,874
Middle Atlantic	179,002	8	125,641	15,873	109,768	53,361	11,154	42,207
Lake	170,690	7	123,398	37,207	86,191	47,292	10,400	36,892
Central	252,273	11	156,338	10,720	145,618	95,935	5,455	90,480
South	792,339	33	429,900	262,959	166,941	362,439	181,797	180,642
Pacific Coast	429,863	18	75,906	75,386	520	353,957	353,131	826
North Rocky Mountain	263,212	11	104,604	104,604	----	158,608	158,608	----
South Rocky Mountain	144,805	6	29,555	29,282	273	115,250	115,250	----
Total	2,382,097	100	1,102,143	550,586	551,557	1,279,954	856,033	423,921

Table 3 gives the regional estimates for softwoods and hardwoods on cordwood and saw-timber areas. The volume on cordwood areas is almost exactly divided between hardwoods and softwoods. Two thirds of the total volume, including practically all of the hardwoods, is in the East, where are the vastly greater cordwood areas.

In many instances cordwood stands may properly be handled on short rotation, for such products as pulpwood, fence posts, fuel wood, etc., or where some necessity enters in to make the cutting of the young stand both desirable and profitable. On the whole, however, the primary function of the stands on cordwood areas should be to serve as essential forest capital or growing stock, to be developed into saw timber rather than to be cut as cordwood. This statement is predicated on the belief that, broadly speaking, and in the light of present knowledge, the bulk of our forests should be managed primarily to produce saw timber, both to obtain the greatest return on the investment and at the same time to meet most adequately future timber requirements. To accomplish this, however, something better than the present average of nine cords per acre should be present. The indication is that the majority of cordwood areas are subnormally stocked and that they need building up if the future forest is to be adequately productive.

The trees below saw-log size, on a large proportion of the saw-timber area (table 4) should be considered as growing stock rather than as timber available for harvesting. Over a third of the total possible cordwood supply on saw-timber areas is estimated to be in the form of tops and limbs of saw-timber trees. As a means of preserving growing stock and conserving waste, it is highly desirable that this material should be utilized up to the measure of present feasible and economical woods practice. Leaving this material in the woods to burn or rot, according to present general practice, represents far more than the mere loss of so much raw material. Progress in utilizing such material will not only have the practical effect of increasing the country's wood supply; it will facilitate fire prevention and control, curb somewhat the tendency toward the too-early cutting of promising saw timber, and leave the land in better condition for restocking.

TABLE 4.—*Stand of cordwood on saw-timber areas in the United States, by type of material and region*

Region	Total		Small trees [1]			Tops and limbs [2]		
			Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Thousand cords	*Percent*	*Thousand cords*	*Thousand cords*	*Thousand cords*	*Thousand cords*	*Thousand cords*	*Thousand cords*
New England	93,112	7	69,872	12,036	57,836	23,240	8,202	15,038
Middle Atlantic	53,361	4	40,556	9,095	31,461	12,805	2,059	10,746
Lake	47,292	4	28,855	8,103	20,752	18,437	2,297	16,140
Central	95,935	8	75,114	4,730	70,384	20,821	725	20,096
South	362,439	28	280,104	151,436	128,668	82,335	30,361	51,974
Pacific Coast	353,957	28	103,179	102,897	282	250,778	250,234	544
North Rocky Mountain	158,608	12	120,264	120,264	----------	38,344	38,344	----------
South Rocky Mountain	115,250	9	76,243	76,243	----------	39,007	39,007	----------
Total	1,279,954	100	794,187	484,804	309,383	485,767	371,229	114,538

[1] Less than saw-timber size but large enough for cordwood.
[2] Of saw-timber trees; only the tops in the case of softwoods.

One effective way for reducing and utilizing not only logging waste but also wood waste in general is to be found in the integration of a variety of wood-using industries, either under one ownership or around an industrial wood-using center. Such a set-up results in the utilization of large volumes of the different forms of wood waste, and in turn permits of the specialization required in the manufacture of diverse mechanical and chemical products. Also, improved logging, manufacturing, and marketing methods doubtless can be developed. Research can aid in all these things, especially in improving the usefulness of wood as wood, and in creating new chemical and other products derived from wood.

In brief, requirements for cordwood material ordinarily should not be allowed to impair the growing stock on either saw-timber or cordwood areas, but should be satisfied, first, with as complete utilization as is practicable of tops and limbs on saw-timber areas; and, second, by improvement cuttings on areas where growth of the remaining stand can thereby be increased. Beyond this, and certain obviously exceptional instances where the only economical and reasonable course is a cordwood rotation, the emphasis should consistently be placed on the development of cordwood into saw-timber stands.

PULPWOOD

Pulpwood supplies present a highly specialized problem involving many economic and technical complexities, some of them matters of world supply and demand. Although a satisfactory estimate of economically usable present pulpwood supplies can hardly be attempted, it may be appropriate to present some quantitative estimates of the supplies of species either now cut in quantity for pulpwood or which seem to be technically capable of use by the pulp and paper industry.

The relation of pulpwood requirements and supplies is not static. The tendency in pulp and paper manufacture as in other fields of wood utilization is toward an increasing number of species regarded as suitable, with a consequent enlargement of the volume of potential pulpwood supplies. There has been a drift toward lower requirements as to size, form, and quality of material. In some regions, notably the Pacific Coast, a large part of the pulpwood is cut from saw-timber trees, with the tops and limbs left unutilized in the woods. In other regions, such as the Lake and South, much of the pulpwood comes from cordwood stands.

Table 5 shows the gross estimate of the species more commonly used for paper pulp by regions, and for softwoods and hardwoods separately. This is presented without any implication that these supplies are anything like completely available in an economic sense either nationally or for any single region. Nor is any prediction here attempted as to what proportion may ultimately be cut for pulpwood and what for other purposes.

The 1,830 million cords thus indicated constitutes about one third of the gross volume of all commercial forest material in the United States—saw timber 860 million cords, or 47 percent; small trees on saw-timber areas 420 million cords, or 23 percent; and cordwood on cordwood areas 550 million cords, or 30 percent. Largely because of the inclusion of southern yellow pines (now used mainly for sulphate pulp) the South is shown to have two fifths of the total supply. The Pacific Coast region with only spruce, hemlock, and true fir included has one fifth. If the saw-timber stands of Douglas fir, ponderosa pine, western white pine, sugar pine, and larch—all western species potentially important for pulpwood—were included another 1,800 million cords would be added.

TABLE 5.—*Stand of principal kinds of wood now used in pulp and paper manufacture, by regions*

Kind of wood	Total [1]	New England	Middle Atlantic	Lake
	Thousand cords	*Thousand cords*	*Thousand cords*	*Thousand cords*
Softwoods:				
Spruce and fir	431, 242	45, 030	5, 931	17, 526
Hemlock	206, 825	10, 467	9, 100	12, 619
Southern yellow pine	623, 525	----------	8, 751	----------
White, Norway, and jack pine	66, 404	24, 190	14, 575	25, 242
Tamarack	1, 986	14	----------	1, 972
Total	1, 329, 982	79, 701	38, 357	57, 359
Hardwoods:				
Cottonwood and aspen	30, 463	10, 590	1, 752	10, 662
Yellow poplar	38, 702	152	3, 338	----------
Birch, beech, and maple	305, 404	115, 235	68, 581	74, 610
Gum	24, 694	----------	2, 601	----------
Total	499, 263	125, 977	76, 272	85, 272
All species	1, 829, 245	205, 678	114, 629	142, 631

[1] Includes material suitable for saw logs, small trees on saw-timber areas, and cordwood on cordwood areas.

TABLE 5.—*Stand of principal kinds of wood now used in pulp and paper manufacture, by regions*—Continued

Kind of wood	Central	South	Pacific Coast	North Rocky Mountain	South Rocky Mountain
	Thousand cords	*Thousand cords*	*Thousand cords*	*Thousand cords*	*Thousand cords*
Softwoods:					
Spruce and fir	610	781	205,861	[2] 48,174	107,329
Hemlock	3,962	3,883	166,794	----------	----------
Southern yellow pine	10,453	604,321	----------	----------	----------
White, Norway, and jack pine	848	1,549	----------	----------	----------
Total	15,873	610,534	372,655	48,174	107,329
Hardwoods:					
Cottonwood and aspen	1,651	5,535	----------	----------	273
Yellow poplar	12,090	23,122	----------	----------	----------
Birch, beech, and maple	31,430	15,548	----------	----------	----------
Gum	9,070	113,023	----------	----------	----------
Total	54,241	157,228	----------	----------	273
All species	70,114	767,762	372,655	48,174	107,602

[2] Includes western hemlock.

Over a third of the estimated pulpwood stands, or 638 million cords, consists of spruce, fir, and hemlock—species suited for all four types of pulp, but especially desired for mechanical and sulphite pulps which make up about two thirds of our total pulp requirements. The Pacific Coast region has about 60 percent of this spruce-fir-hemlock supply. Less than a third, or 500 million cords, consists of yellow poplar, birch, beech, maple, gum, cottonwood, and aspen—eastern species used mostly for soda pulp. The remaining 692 million cords consist mostly of southern yellow, white, Norway, and jack pines—species used largely for sulphate pulp.

TOTAL VOLUME OF TIMBER

Volumes in terms of cubic feet afford the only practical basis for measuring the total volume of timber and for comparing directly the total volume of timber with the total volume of timber growth or the total volume of timber depletion.[1] Table 6 and figure 6 furnish detailed information on the total cubic foot volumes for the several regions. Of the total volume of 487 billion cubic feet, nearly half or 229 billion cubic feet is saw-log material. The volume in small trees on saw-log areas aggregates 70 billion cubic feet, cordwood areas 100 billion, and scattered trees on restocking areas 18 billion. The volume of wood in the tops, limbs, stumps, long butts, etc., of saw-timber trees makes up the remaining 70 billion cubic feet, of which the bulk falls in the category of so-called woods waste.

[1] It may prove misleading to compare different estimates in cubic feet of the same stand of timber, unless it is known that the same conversion factors, similarly applied, were used in each case. The present estimate in cubic feet of the total volume of timber in the United States, for example, is lower than that of the Forest Service in 1920 in the report on S. Res. 311, the difference being due in part to the use of different conversion factors but mostly to timber depletion.

TABLE 6.—*Total stand (cubic feet) of softwoods and hardwoods in the United States, including saw-timber, cordwood, and restocking areas, by type of material and region*

Region	Saw timber [1]		Small trees [2]		Tops and limbs [3]	
	Softwood	Hardwood	Softwood	Hardwood	Softwood	Hardwood
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*
New England	5,183	4,086	1,082	5,205	738	1,353
Middle Atlantic	1,302	2,918	819	2,831	185	968
Lake	1,453	4,359	729	1,867	206	1,452
Central	458	5,235	425	6,334	65	1,809
South	19,190	13,523	13,629	11,578	2,733	4,678
Pacific Coast	132,917	351	9,243	25	22,520	49
North Rocky Mountain	19,269	----------	10,824	----------	3,451	----------
South Rocky Mountain	18,815	----------	6,860	----------	3,509	----------
Total	198,587	30,472	43,611	27,840	33,407	10,309

Region	Other [4]		Cordwood and restocking areas		Total area		
	Softwood	Hardwood	Softwood	Hardwood	Total stand	Softwood	Hardwood
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*
New England	260	286	1,835	5,202	25,230	9,098	16,132
Middle Atlantic	64	204	1,661	11,697	22,649	4,031	18,618
Lake	73	305	3,349	7,757	21,550	5,810	15,740
Central	22	366	1,110	14,832	30,656	2,080	28,576
South	960	947	28,451	18,122	113,811	64,963	48,848
Pacific Coast	17,540	56	8,956	75	191,732	191,176	556
North Rocky Mountain	2,076	----------	12,148	----------	47,768	47,768	----------
South Rocky Mountain	1,465	----------	2,650	24	33,323	33,299	24
Total	22,460	2,164	60,160	57,709	486,719	358,225	128,494

[1] Only the portion of tree suitable for saw logs, saw-timber area.
[2] Less than saw-timber size but large enough for cordwood, saw-timber area.
[3] Of saw-timber trees; only the tops in the case of softwoods.
[4] Stumps, long butts, and breakage, saw-timber area.

The preponderant position of the Pacific Coast region stands out with respect to total volume in much the same manner, although not so strikingly as in connection with saw-log volume. A main reason, of course, is the great amount of virgin saw timber in the Pacific Coast, but another reason is the extremely depleted growing stock or forest capital in the East, generally speaking. The Pacific Coast region with 13 percent of the total forest area contains 40 percent of the total timber volume and nearly 60 percent of the saw timber. At the other extreme, the Lake region with nearly as much land contains less than 5 percent of the total timber volume and only about 2 percent of the saw timber. The South, in an intermediate position, with 40 percent of the forest area contains only 25 percent of the total volume and 14 percent of the saw timber.

OWNERSHIP OF TIMBER SUPPLIES

Forest-land ownership has been discussed and the importance of its character has been emphasized in the section, "Forest Land the Basic Resource." Of corresponding importance is the nature of the ownership of the standing timber. It bears upon the time

and rapidity of cutting in respect both to market conditions and to organization for sustained yield regionally and nationally. It influences the care with which the timber is utilized. And finally, and very importantly, it influences the character of the cutting, the care that is exercised and the measures taken before, during, and after cutting to insure the establishment and protection of restocking—the sine qua non to keeping forest lands continuously productive. These matters are so closely related to the ownership of the forest land that reference to the discussion of that subject should be made. The brief discussion of timber stand ownership at this point should be regarded as supplemental to that of lands.

TABLE 7.—*Ownership of stands of saw timber in the United States, by regions*

Region	All stands		Federally owned or managed			
			Total	National forest	Indian reservation	Other
	Million ft. b. m.	*Per cent*	*Million ft. b. m.*	*Million ft. b. m.*	*Million ft. b. m.*	*Million ft. b. m.*
New England	57,875	3	1,119	1,119	----------	----------
Middle Atlantic	26,150	2	98	94	----------	4
Lake	35,887	2	2,284	1,200	1,084	----------
Central	34,622	2	449	444	----------	5
South	199,297	12	3,868	3,653	195	20
Pacific Coast	1,041,628	62	421,571	357,198	21,342	43,031
North Rocky Mountain	146,388	9	93,130	88,840	2,290	2,000
South Rocky Mountain	125,956	8	114,983	99,917	6,995	8,071
Total	1,667,803	100	637,502	552,465	31,906	53,131

Region	State, county, and municipal	Private		
		Total	Industrial	Farm woodland
	Million ft. b. m.	*Million ft. b. m.*	*Million ft. b. m.*	*Million ft. b. m.*
New England	1,363	55,393	47,421	7,972
Middle Atlantic	221	25,831	13,831	12,000
Lake	870	32,733	21,771	10,962
Central	107	34,066	16,613	17,453
South	312	195,117	146,850	48,267
Pacific Coast	26,155	593,902	568,696	25,206
North Rocky Mountain	11,527	41,731	40,223	1,508
South Rocky Mountain	1,457	9,516	9,452	64
Total	42,012	988,289	864,857	123,432

SAW TIMBER

Ownership of saw timber is of special importance, because premature or untimely liquidation of saw timber especially, upsets market conditions for forest products, with results that lead the industrial forest owner to seriously doubt the wisdom or the economic soundness of forestry for him. The comparatively long rotations incident to saw timber production add to the complexities of management. It is in connection with saw timber also that the problems of wise allocation of cut for sustained yield organization of forest lands, regionally and nationally, chiefly reside.

Table 7 and figure 7 present the United States regional and total distribution of saw timber for industrial, farm woodland, and public

ownership. Industrial ownership includes ownership by land, lumber, pulp and paper, and mining companies, naval stores operators, railroads, and miscellaneous individuals or agencies. According to these estimates, 865 billion board feet, or 52 percent of the saw timber stand, is industrially owned. This corresponds fairly closely with the 48 percent of the saw-timber area thus owned. By and large it includes the best and most accessible saw timber. Sixty-six percent of all this industrial saw timber is in the Pacific Coast region. Chiefly in this timber are the problems which involve precipitate liquidation, with all its demoralizing influence not only upon the market but for the time being upon private forestry practice in the eastern United States. This ownership class contains a notably larger proportion of saw-timber volume than of area in the Pacific

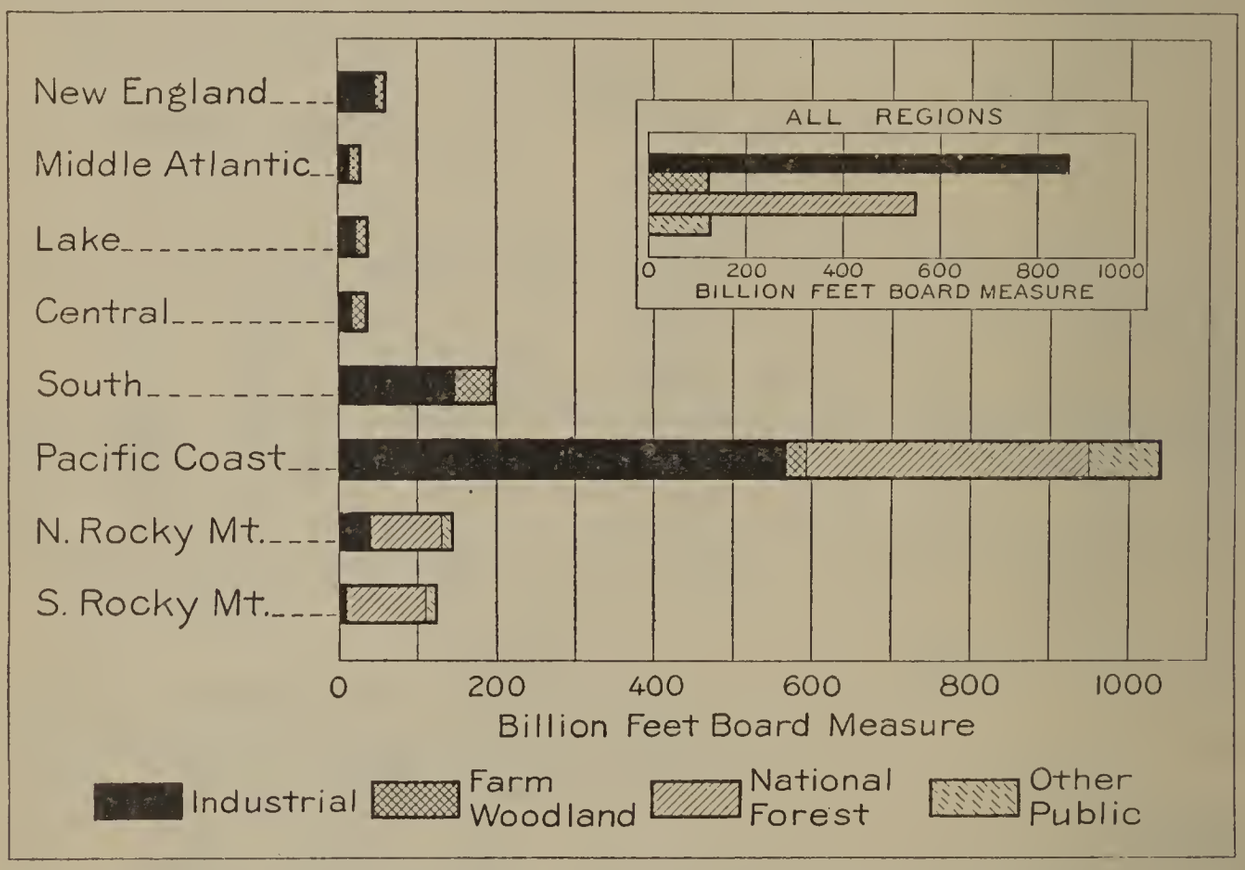

FIGURE 7.—Ownership of saw-timber stand of the United States by regions.

Coast region, as would naturally follow from the fact that in that region the better stands are industrially owned. The percentages are 55 and 39 respectively.

Farm woodlands include 123 billion board feet or 7 percent of the total saw-timber stand. With a relatively stable ownership, except on submarginal farms, and more subject to something like a rough selection system of cutting, they present less critical problems than do the industrial saw-timber stands, generally.

Public ownership includes the remaining 680 billion board feet, or 41 percent of the saw-timber stands. It includes a larger proportion of relatively inaccessible timber in the West. Although the stand per acre is less than for industrial ownership in the West, the proportion of saw-timber stands in public ownership in all regions is somewhat in excess of the corresponding 33 percent of the area of the country as a whole. By the nature of the case, public ownership of saw timber for the most part is committed to a conservative policy of cutting designed to place stumpage on the market only when consistent with economic conditions and the dictates of sound forestry.

Of the publicly owned or managed saw timber 552 billion board feet or 81 percent is included in the national forests, 41 billion is involved in the Oregon and California land grants, and about 32 billion board feet is administered by the Indian Service. States, counties, and municipalities together hold 42 billion board feet, of which the portion held by counties and municipalities is less than half a billion board feet.

There is a dearth of publicly owned or managed saw timber in the East, where it amounts to only 11 out of 680 billion board feet. This in itself emphasizes the desirability of considering an expanded program of public forest and forest land ownership in the East.

An examination of the details as to relative saw-timber stand conditions for the different ownerships emphasizes again that the national situation is a complex of widely varying regional conditions, each so much affected by peculiar local factors that it is unsafe to go very far in drawing general conclusions. Table 8 shows the stand per acre on an ownership basis for groups of regions within which conditions are roughly comparable. Not only are the stands for the Pacific Coast much heavier in general than the average for the rest of the country but they are much heavier than those of any other single region. Within the Pacific Coast region the industrially owned old-growth is more than twice as heavy per acre as that on farm woodlands and publicly owned. This emphasizes again the fact that industrial ownership, by and large, includes the best of the saw timber.

TABLE 8.—*Average stand of saw timber per acre, by class of ownership, region, and character of growth*

Region	Industrial			Farm woodland			Public		
	Area	Total stand	Stand per acre	Area	Total stand	Stand per acre	Area	Total stand	Stand per acre
	Thousand acres	*Million ft.b.m.*	*Feet b.m.*	*Thousand acres*	*Million ft.b.m.*	*Feet b.m.*	*Thousand acres*	*Million ft.b.m.*	*Feet b.m.*
Pacific Coast region:									
Old growth	14,804	532,991	36,003	1,032	16,229	15,726	23,056	409,409	17,757
Second growth	2,363	35,705	15,110	708	8,977	12,679	2,177	38,317	17,601
Total	17,167	568,696	33,127	1,740	25,206	14,486	25,233	447,726	17,744
Rocky Mountain regions:[1]									
Old growth	4,601	47,316	10,284	211	943	4,469	28,483	210,637	7,395
Second growth	1,333	2,359	1,770	187	629	3,364	4,952	10,460	2,112
Total	5,934	49,675	8,371	398	1,572	3,950	33,435	221,097	6,613
Eastern regions:[2]									
Old growth	22,241	107,394	4,829	2,192	13,351	6,091	2,235	7,505	3,358
Second growth	45,210	139,092	3,077	31,383	83,303	2,654	1,477	3,186	2,157
Total	67,451	246,486	3,654	33,575	96,654	2,879	3,712	10,691	2,880
All regions:									
Old growth	41,646	687,701	16,513	3,435	30,523	8,886	53,774	627,551	11,670
Second growth	48,906	177,156	3,622	32,278	92,909	2,878	8,606	51,963	6,038
Aggregate	90,552	864,857	9,551	35,713	123,432	3,456	62,380	679,514	10,893

[1] North and South Rocky Mountains.
[2] New England, Middle Atlantic, Lake, Central, and South.

The relatively low averages for farm woodland are doubtless in part due to the very small proportion of old growth as well as to the typically more selective character of the farm woodland saw timber resulting from partial cutting at shorter intervals.

CORDWOOD

Table 9 and figure 8 supply information as to the regional and United States distribution by ownership of cordwood on cordwood areas. Fifty-two percent of this cordwood is industrially owned, 32 percent is in farm woodland, and but 16 percent is publicly owned. As would be expected, the percentage in farm woodland is much larger, and that in public much smaller, than the corresponding percentages for saw timber. And, of course, owing to the vastly greater areas of this type of stand in the East, the proportions of it in all ownerships are very much greater than for saw timber. The

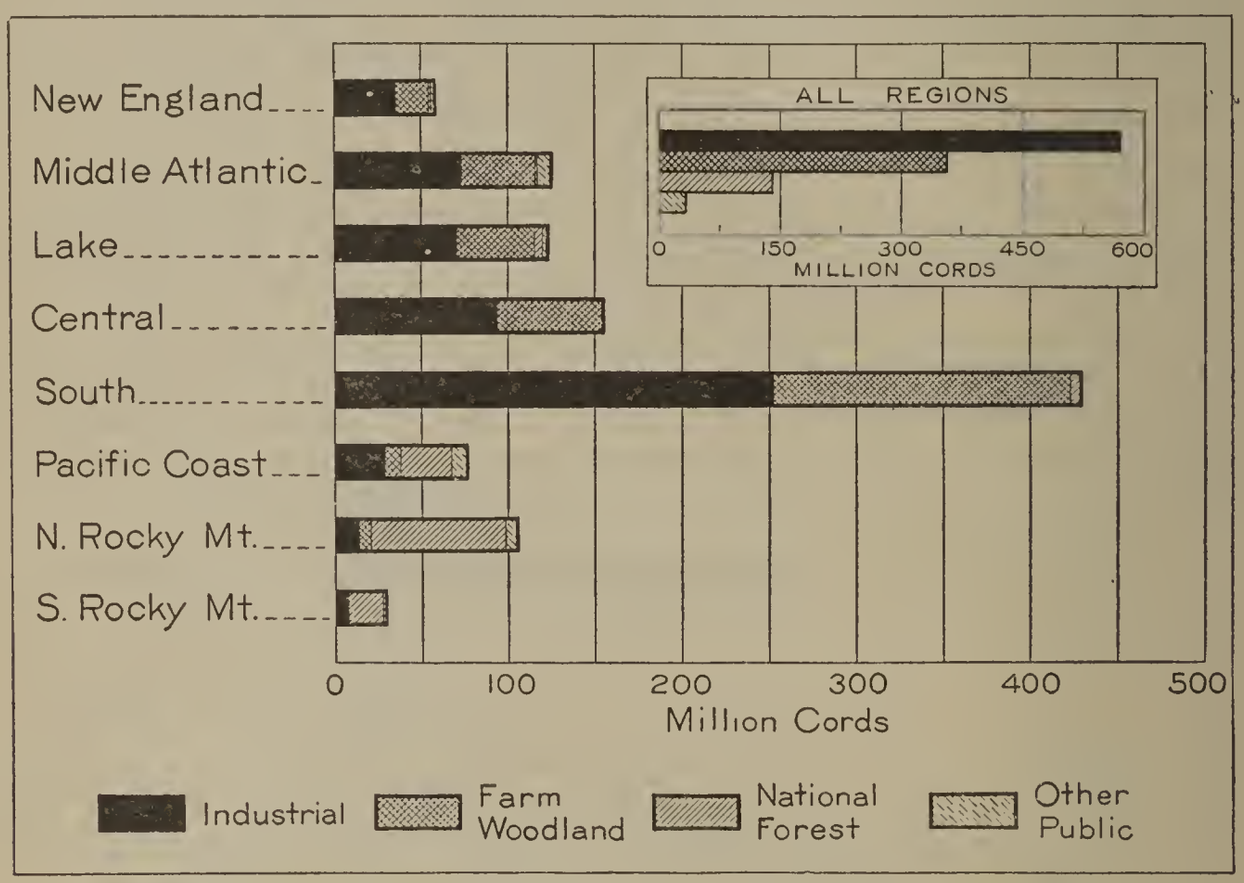

FIGURE 8.—Ownership of stand of cordwood on cordwood areas by regions.

industrial and farm woodland cordwood volumes of the South are far in excess of those of any other region.

TABLE 9.—*Ownership of stands of cordwood on cordwood areas in the United States, by regions*

Region	All stands		Federally owned or managed			
			Total	National forest	Indian reservation	Other
	Thousand cords	*Percent*	*Thousand cords*	*Thousand cords*	*Thousand cords*	*Thousand cords*
New England	56,801	5	1,253	1,253	----------	----------
Middle Atlantic	125,641	11	718	608	----------	110
Lake	123,398	11	5,197	4,633	564	----------
Central	156,338	14	743	743	----------	----------
South	429,900	39	6,018	5,963	30	25
Pacific Coast	75,906	7	37,155	28,700	2,869	5,586
North Rocky Mountain	104,604	10	83,402	78,871	2,240	2,291
South Rocky Mountain	29,555	3	22,324	20,755	799	770
Total	1,102,143	100	156,810	141,526	6,502	8,782

TABLE 9.—*Ownership of stands of cordwood on cordwood areas in the United States, by regions*—Continued

Region	State, county, and municipal	Private		
		Total	Industrial	Farm woodland
	Thousand cords	*Thousand cords*	*Thousand cords*	*Thousand cords*
New England	2,098	53,450	33,845	19,605
Middle Atlantic	8,794	116,129	73,225	42,904
Lake	2,726	115,475	69,970	45,505
Central	353	155,242	93,932	61,310
South	269	423,613	251,666	171,947
Pacific Coast	1,740	37,011	27,582	9,429
North Rocky Mountain	2,152	19,050	13,025	6,025
South Rocky Mountain	482	6,749	6,732	17
Total	18,614	926,719	569,977	356,742

AVAILABILITY OF TIMBER STANDS

The statistics for timber stands given in the preceding discussion are by no means to be interpreted as measuring the quantity of timber supplies available for cutting. Two major considerations materially reduce these stand figures when they are expressed in terms of available supply. One consideration is the necessity for maintaining a growing stock or forest capital consistent with the sustained yield of forest products to be obtained. The higher the rotation age the larger the volume of this growing stock must be. If, for example, saw timber is the object of management the growing stock must be greater than it would be if pulpwood and other small material only are to be grown. If, as is the case with most of the eastern regions, the growing stock is already too small it should be built up. Cutting, then, should be restricted to improvement operations, except as the presence of mature stands may require a more extensive cut, or pressing social or economic conditions of the locality concerned may justify the sacrifice of future yields. This growing stock relationship to available supplies will be further discussed in the subsection on Timber Growth.

The second major consideration is that of economic availability. After the requirements of adequate growing stock have been satisfied, or even where they are not, there is still the question whether a particular stand can be cut now or prospectively with a profit or at least without financial loss. Economic availability depends upon such things as volume of timber per acre, its size and quality, the proportion of inferior species, logging difficulties, length of haul to mill, the cost of milling and of getting the manufactured product to market, and the price that can be obtained for the product.

There is but little thoroughly reliable information on present economic availability. Such information as there is, however, warrants the broad judgment that but little more than half of the estimated 1,668 billion board feet of saw timber in the United States can be cut profitably on the basis of the operating costs and mill lumber prices of recent years (fig. 9), or would on this basis have a positive conversion value.

The limits of economic availability are ever changing. As the more accessible and desirable stands have been cut out, logging and

milling practices have, from the standpoint of engineering and mechanics, become much more efficient. It has become, therefore, increasingly feasible to log more remote areas. At the same time, knowledge of the adaptability of the less desirable species for special purposes has grown and the trend has been toward the utilization of the less desirable species. In view of such developments, it would be unsafe to prophesy as to the proportion of existing timber stands that may ultimately prove to be economically available. It seems reasonable to believe, however, that competing or substitute materials for wood, which already have become a powerful factor, will prevent the indefinite pushing back of the limits of availability.

REGIONAL AVAILABILITY OF SAW TIMBER

The economic availability of saw timber, as estimated very roughly by regions, will give concrete evidence of the wide divergence that

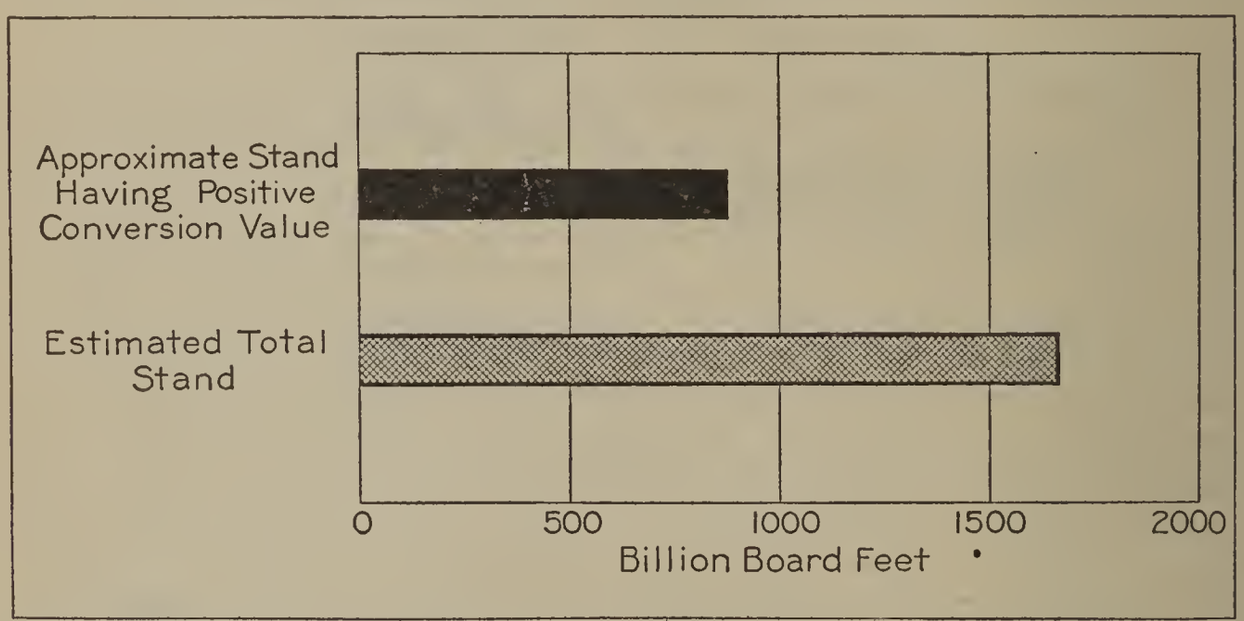

FIGURE 9.—Approximate stand of saw timber in the United States having a positive conversion value on the basis of 1925–29 lumber prices (mill) and operating conditions, in comparison with total saw-timber stand.

may exist between stand and availability in any estimate of national timber supply.

NEW ENGLAND, MIDDLE ATLANTIC, LAKE, AND CENTRAL REGIONS

The combined saw-timber stand of these four regions amounts to about 155 billion board feet or less than one tenth of the national supply. Hardwoods make up two thirds of the total. Old-growth saw timber comprises less than 60 billion board feet. The bulk of it is confined to the more remote and sparsely settled sections with poor transportation facilities. Many of these old-growth stands have been so heavily culled that the remaining overmature and defective timber cannot be marketed profitably. The fact that there are any old-growth stands left in these four regions, which contain 67 percent of the population of the United States, but furnish only 15 percent of the total lumber cut, indicates that the bulk are relatively inaccessible, scattered, or of poor quality.

Much of the second-growth saw timber, largely as the result of fires and of cullings for the more desirable timber, consists of little more than scattered trees that barely meet the minimum requirements

for saw logs, in mixture with badly defective trees or those of less desirable species. In short, these stands have progressively deteriorated. In the main, they can supply little but common lumber, and a considerable proportion cannot be cut at a profit.

SOUTH REGION

The saw-timber stands of the South, which aggregate some 200 billion board feet, are in general more accessible and of better quality than those of the other four eastern forest regions. The large lumber cut of the region alone would indicate this. The South until recently has produced from 15 to 17 billion board feet of lumber annually, or not far from half of the softwood and of the hardwood lumber production of the entire country.

Much of the 121 billion board feet of softwood in the South is found in the coastal plain from Virginia to Texas, with the bulk of the remainder either on the bluffs and uplands east of the Mississippi River or on the rocky hills of central Alabama, west central Arkansas, and southeastern Oklahoma. The flat coastal plain is uniformly one of the cheapest in the United States for logging operations. Except for limited areas in the mountains and swamps the entire South presents few difficulties in logging.

Less than one third of the softwood saw timber, however, is old growth. The bulk of the original forests has been cut since 1890. Largely because of uncontrolled fires and the absence of seed trees, large areas were slow to restock. Cutting and destructive turpentining have further tended to limit the size and quality of the second-growth saw timber. Not only is much of the second growth comparatively young and therefore barely of saw-log proportions, but it is frequently found on small, scattered areas. Young second growth, of course, will not, as a rule, yield the strong and durable structural timber, fine-grained and wide finish, or the other better grades of lumber that are now cut from large, mature trees. Nevertheless, a large lumber cut is now coming from small, low-grade second growth. Although cutting of this small second growth for lumber is thought to be unwise, because the trees are not financially mature, it may be said, from the standpoint of accessibility only, that substantially all of the second-growth softwood saw timber of the South can be classed as available supplies.

The hardwoods in the South aggregate nearly 80 billion board feet, as compared with the annual cut in that region of 7½ billion. Old-growth accounts for only 33 billion feet. A substantial proportion of the hardwood stands cannot at present be utilized profitably for lumber, veneer, and similar products. Some of the stands, for example, are far distant from transportation facilities or considerably isolated by cut-over areas. Others contain large numbers of small, inferior, or defective trees.

Some 35 billion feet of hardwoods is located in that portion of the southern Appalachians within the region, the piedmont plateau, and the uplands of Arkansas, Mississippi, eastern Texas, and Oklahoma. The situation in the southern Appalachians and piedmont plateau is fairly typical of the upland forests. After many years of cutting, the once heavy original forests are nearing the end. Declining supplies, together with changing market conditions, have brought about repeated and progressively heavier cullings of the remaining stands.

Forest fires, insects, and chestnut blight have also taken their toll. Until recent years, however, enough was left to make possible the relogging of areas already cut over, especially as the market for pulpwood and tanning-extract wood enabled the utilization of small timber and previously worthless species. Of late, large numbers of portable mills, as in the softwood forests, have operated on cut-over or culled lands, cleaning up the remaining saw-log and tie timber. While there still remain in the mountains a number of large old-growth tracts, as well as many promising second-growth stands, much of the hardwood timber supply is either relatively inaccessible or of poor quality. The farm woodlands which dot the valleys and plateau consist for the most part of small tracts which have been cut over several times. They, however, are more accessible than the mountain timber.

About 45 billion board feet, including the better and more accessible hardwood stands, occurs in the bottomlands and swamps of the coastal plain and lower Mississippi Valley. Approximately 30 billion of this, of which more than one third is old growth, is in the wide river bottoms of Arkansas, Louisiana, and Mississippi. Exploitation in the lower Mississippi Valley has progressed steadily since 1900; the factories of the Carolinas, the Ohio Valley, and the Lake States, once regionally independent, have been drawing on the lower Mississippi Valley hardwoods. In 1929, about one fourth of the total hardwood lumber cut of the United States came from Arkansas, Louisiana, and Mississippi. At the present rate of cutting the virgin stands of the lower Mississippi Valley will be cut out in a few years. However, second-growth and old-field stands are supplying an increasingly large percentage of the hardwood cut.

Conditions in Louisiana, the leading hardwood lumber producer, are in many respects typical of the lower Mississippi Valley. That State in 1928 had about 80 hardwood mills each with a daily output of 30,000 board feet or more. A survey of 60 mills (made cooperatively by the State of Louisiana and the Forest Service) revealed 5 mills with 10 to 15 years' supply of timber, 6 with 5 to 10 years' supply, 32 with 1 to 5 years' supply, and 17 with no timber but operating on logs bought in the vicinity of the mills. Although the available supplies may have been underestimated, indications point to a marked downward trend in merchantable hardwood timber supplies in the State.

WESTERN REGIONS

It has already been shown that 1,314 billion of the country's total saw-timber stand of 1,688 billion board feet is in the West. Much of it is high up in the mountains where logging is very costly. On the other hand, highly developed mass-production methods in woods and mill, combined with rail and water transportation, have rendered the better and more accessible of these stands readily available to the far distant central and eastern markets. Just what proportion of the western timber should be considered available to the country generally is problematical. It depends to a large extent, of course, upon how much the large and distant markets will pay.

It is estimated that about 600 billion board feet, or somewhat less than half of the western supply, would have a positive realization value on the basis of the logging and milling methods and costs and of lumber prices that obtained during the 1925–29 period; or in other words, would be classed as economically available on that basis. Further

improvements in logging and milling practices resulting in lower costs, or enhancement in lumber prices would automatically make more of the western timber available. Undoubtedly there will continue to be changes of this character. Howver, some forest engineers believe that large volumes can never be economically utilized.

THE MIGRATION OF FOREST INDUSTRIES

While the migratory habits of our forest industries can be explained partly by expanding markets, they are largely the result of the exhaustion of local timber supplies—a situation which sustained yield management of the regional forest resources would have largely obviated. The various migrations of the forest industries throw considerable light on present available forest supplies. The following salient facts are given for a few representative industries.

LUMBER INDUSTRY

In softwood lumber manufacture, the depletion of available virgin timber supplies has marked an industrial cycle in each forest region. Local industries developed, dominated the consuming markets of the country, and declined at last so far as to be unable to meet even the regional requirements. This cycle has been characterized by a transition from light culling to clean cutting of good timber and poor alike, and by a shift from the more to the less desirable species. The peak of softwood lumber production moved successively from New England to New York, to Pennsylvania, and thence to the Lake States. It culminated in the Lake region in the early nineties with a lumber cut of about 9 billion board feet, or about one half of the softwood cut of the entire country.

In their turn, the South and the Pacific coast regions have held the commanding position. Southern softwood lumber passed a peak of 16 billion board feet in 1909. For over a decade Pacific coast lumber has dominated Lake States markets and has now entered in appreciable quantities the markets of the South. In 1929, Washington, Oregon, California, and Idaho together produced over 15 billion feet of lumber, or about half of the total softwood lumber cut of the country in that year.

Hardwood lumber production centers have shifted in much the same way. The industry began early in New England and along the Atlantic coast, spread slowly westward through New York and Pennsylvania as the better and more accessible local supplies were cut out, and became important in Ohio and the other Central States after water and rail transportation was developed. From there it spread north into the Lake States and south into Kentucky and Tennessee and the southern Appalachian Mountains. After successively depleting the available virgin stands of these various regions, the industry moved to the lower Mississippi Valley which embraced the largest remaining stand. Now the end of abundant virgin supplies in the lower Mississippi Valley is pretty definitely in sight. Hardwoods occur in the West only to a negligible extent.

FURNITURE INDUSTRY

The furniture industry is one of a group of highly specialized industries that are confronted by a growing scarcity of suitable raw

material. These industries also began in the Northeast, where local supplies of black walnut, cherry, white oak, birch, and maple were at first ample for their exacting requirements. The approaching exhaustion of these supplies, together with widening markets, forced the industries westward. They expanded rapidly in the last quarter of the nineteenth century, drawing heavily on the magnificent virgin hardwood forests of the Lake and Central States. Massachusetts, New York, and Pennsylvania, and later southern Michigan and the lower Ohio River region, became successively important in furniture manufacture. The establishment of furniture factories in North Carolina signalized a shift from northern hardwoods to the large supply of southern hardwoods, including southern oak and red gum. Now these factories, as well as those of the North, obtain much of their raw material from the lower Mississippi Valley. With the cutting out of the virgin hardwoods in these forests, which are now comparatively remote and inaccessible, the industry will have exhausted practically its last reserve of old-growth hardwoods.

VENEER INDUSTRY

The veneer industry faces much the same situation in the production of high-grade veneers from eastern hardwoods. In the North, raw material must now be obtained from second-growth stands, at high cost and often very wastefully. The large hardwood logs practically clear of defects, from which high-grade veneers are customarily produced, can be obtained only from old-growth stands. Inevitably, therefore, the industry has turned to the South for much of its raw material. Red gum is now used in larger quantities for veneer than any other wood, imposing a heavy drain on the best-quality timber of this species. Tupelo, also a southern species, stands second in quantity used for hardwood veneers.

The last decade has been marked by a striking increase in the manufacture of softwood veneers, particularly from Douglas fir, southern yellow pine, and ponderosa pine. Such veneers are used largely for shipping containers, and for built-up stock for doors, trunks, and parts of furniture and automobiles. The large, old-growth timber of the West is especially well adapted to conversion into veneers. Douglas fir leads all other softwoods in this use, being second only to red gum in total quantity consumed. Further large expansion of the use of western softwoods for veneer may confidently be expected.

Southern yellow pine is third in the quantity of wood consumed in veneer manufacture. Southern pine veneers supply the heavy demand in the South for fruit and vegetable crates. Although the southern pines are by no means as plentiful nor as favorable for veneer production as the western softwoods, a further increase of the softwood veneer industry in the South may be expected.

The total quantity of wood used in this country for veneers has doubled in the past decade. Among native species the use of ash, birch, and oak has decreased. All others have increased.

HANDLE INDUSTRY

Handles embrace a wide range of products—from the small cheap handles made of almost any wood, to axe or rake handles which are very exacting in their requirements. High-grade ash and hickory, used for the better-class products, make up three fourths of the raw

material used by the industry; no satisfactory substitute has been found for these woods. The good-quality, dense, tough ash, much preferred for handles, was formerly supplied from excellent stands in the States north of the Ohio River, but these are now largely cut out and most of the present supply must be obtained from the lower Mississippi Valley. Present supplies of hickory come mainly from the South where the greater part of the better and more accessible timber has been taken. Not only must larger areas be covered to obtain suitable material, but more and more it is becoming necessary to work into the districts remote from transportation facilities.

VEHICLES AND AGRICULTURAL IMPLEMENTS

The vehicle and agricultural implements industries, located mainly in the Middle West, compete with the handle industry for southern hickory and ash. They also compete with other wood-using industries, including furniture and veneer manufacturers, for other hardwoods. Notwithstanding the extensive substitution of metal for wood in vehicles and agricultural implements, these industries are greatly handicapped by a scarcity of suitable timber for their products.

AVAILABILITY OF PULPWOOD SUPPLIES

The statistics of total timber stand of paper pulpwood species, given in table 5, require interpretation in the light of present availability even more than the statistics on saw-timber stands. Thus it appears that for the United States as a whole the present stand of softwoods suitable for pulp is 280 times the normal annual pulpwood cut, and of hardwoods over 800 times the cut. In spite of this, we import more pulpwood, or its equivalent in wood pulp and paper, than we cut in our own forests. Obviously, only a small part of our 1,830 million cords of standing timber of the species now used in pulp and paper manufacture is available to the Nation's mills, or at least as available as some of the foreign supplies.

Sixty years ago the quantity of wood used as a raw material for paper in the United States was insignificant. Today about 85 percent of our paper has its origin in the forest. Wood, in short, is the basic raw material for paper pulp. Although pulp can be produced from any fibrous material, no source of cellulose has yet been discovered which, either in suitability for most types of paper pulp or in cost per unit weight, challenges the supremacy of wood.

Not all kinds of wood, however, are at present available for use in the manufacture of pulp. The spruces, firs, hemlocks, and pines, among softwoods; and cottonwoods and aspens, yellow poplar, birches, beech, maples, and gums, among hardwoods, are now used in sufficient quantities to warrant separate mention. The fact that different species require different processes for reduction to pulp tends to restrict their availability, particularly with respect to established mills.

STANDARD PULPWOODS AND PULPING PROCESSES

There are four standard processes of making paper pulp from wood—the mechanical, the sulphite, the sulphate, and the soda. Each is especially adapted to the manufacture of certain grades of paper or to the pulping of certain woods. The various grades of papers, in fact, usually contain varying proportions of two or more

types of wood pulp. Considerable old paper also mingles with new pulp in various papers, and pulp derived from nonwoody plants mingles with wood pulp in fine papers.

Newsprint, cheap magazine, cheap catalog, and similar papers, are made mostly of mechanical pulp, that is of uncooked wood mechanically ground into a pulp. Only the relatively soft, light colored, nonresinous spruces, firs, and hemlocks are suitable for the manufacture of mechanical pulp or are used enough to be considered commercial sources for this process. The mechanical process is the cheapest of all, and the pulp yield is by far the greatest. The quality of the pulp, however, is so low that in the manufacture of even cheap papers considerable quantities of longer and stronger-fibered pulp are added. Of our total wood-pulp production, mechanical pulp comprises about a third.

The stronger and better-grade papers are made of pulps manufactured by one of the three standard chemical processes—sulphite, sulphate, or soda. In each of these processes a large portion of the wood is removed, leaving fibers consisting of almost pure cellulose. This is accomplished by cooking chips of the wood with a chemical under steam pressure.

Some classes of book, wrapping, bond, and tissue papers are made largely from sulphite pulp, and considerable sulphite is used in mechanical papers. The sulphite process is a little more expensive than the other chemical processes, and the pulp yield is only about half as large as in the mechanical process; but the pulp is very strong and can be readily bleached to a high degree of whiteness. The woods used in the sulphite process are the same as in the mechanical process; the light colored, nonresinous softwoods, such as spruce, fir, and hemlock. Sulphite pulp accounts for about a third of the wood pulp produced in this country.

Kraft or wrapping paper and high-test fiber board are made from sulphate pulp. The standard sulphate process is a little less expensive than the sulphite process; the yield of pulp is about the same. Any long-fibered wood can be used for sulphate pulp, even one which contain resins and other alkaline-soluble materials. Sulphate pulp constitutes about a fifth of our total wood-pulp production.

Book, lithograph, and envelope papers are very often made from a mixture of sulphite pulp and pulp made by the soda process. This mixture gives a sheet of paper which is highly esteemed by printers. The soda process can be applied to softwoods without difficulty, but it is used almost entirely for the reduction of such hardwoods as aspen, cottonwood, beech, birch, and gum. Soda pulp is sometimes used alone in the manufacture of some of the cheaper, bulkier book papers which have very low strength requirements. Of our total wood-pulp production, soda pulp constitutes only about a tenth.

With the above facts as to pulping processes and to woods suited to them as a background, the availability of present pulpwood supplies may be discussed region by region.

REGIONAL SUPPLIES

New England, Middle Atlantic, and Lake regions.—The spruce forests in New England and New York met the combined requirements for both mechanical and sulphite pulps better than those of any other section of the country, so that it has been here, and later in

smaller degree under similar conditions in the spruce and hemlock forests of the Lake region, that the American industry has largely centered. This development also carried with it a considerable part of the sulphate-pulp industry, which could have located elsewhere and made use of other species. Even the soda-pulp industry, which began and is now well developed in Pennsylvania, manufactures a large part of its product from the aspen in the northern spruce forests.

The overcentralization of the industry intensifies the problem created by imports from other countries of pulpwood, pulp, and paper, and it is the chief factor in the situation which necessitates pulpwood imports. Fundamentally, we have imported pulpwood because the supplies of raw material tributary to the pulp mills of the New England, Middle Atlantic, and Lake regions have become increasingly scarce.

Pulp manufacture entered these restricted regions later than lumbering, and has reduced their diminished supplies of timber still further. Many pulp and paper mills have either no timber of their own or only very limited amounts, and few have permanent supplies. In the meanwhile, our paper requirements have grown faster than, under existing conditions, pulpwood could be obtained from our forests or wood pulp and paper could be produced in our mills. To keep up even in part with increasing demands, the industry was forced either to import both pulpwood and wood pulp, or to move to other regions of the United States.

Of late, a paper industry has sprung up in the lower Mississippi Valley, and the industry in the Pacific Coast region has expanded. In the main, however, the industry as a whole has chosen rather to import first pulpwood and then wood pulp and paper, on an ever-increasing scale (described in the later section headed "Timber Requirements") than to move. The principal factors influencing the choice were as follows:

Relatively large plant investments make it more difficult for pulp and paper mills to follow the retreating timber stands than is the case in lumber manufacture. Comparatively few woods, as previously indicated, have been used in paper making. Then, nearness to paper markets has been necessary to keep down transportation costs. These factors and the requirement, in the case of mechanical-pulp manufacture, of abundant and cheap power have tended to confine the production of paper to but few regions. Inertia alone has doubtless been a contributing factor in slowing up seemingly logical development. Perhaps one of the chief factors in the situation has been a lack of the technical knowledge needed to make the best use of the pulping resources of the country as a whole.

The great bulk of pulpwood imports into the New England, Middle Atlantic, and Lake regions consists of spruce and aspen. Fir pulpwood imports are comparatively small, and hemlock even smaller.

About 70 percent of the New England supply of spruce and fir is in Maine. (Table 5.) Perhaps as much as a sixth of the Maine timber is too scattered for profitable cutting, although in reasonably accessible territory. About a quarter is in a region now relatively inaccessible. Although some pulp manufacturers of New England are importing pulpwood from Canada in order to allow their American stumpage to build up by growth the majority are seemingly importing because the regional supply of pulpwood is not as available as

foreign pulpwood, Even less of the New England wood is available if a long-term view is taken of the situation and if the present stands are regarded as absolutely essential forest capital on which interest must be earned in terms of growth. Competition with other uses, particularly lumber, must also be taken into account.

In the Lake States and in the Middle Atlantic region similar conditions of sparseness and inaccessibility of stand, and in the Lake States defectiveness of the fir, combine to make about the same proportion of the stand unavailable to the pulp and paper industry as in New England. Stands are being logged today for spruce pulpwood in New York which contain as little as two cords per acre.

In spite of having a domestic stand over 50 times as great as the annual consumption of domestic and imported wood combined, the Northeastern United States now imports nearly a third of its aspen pulpwood. This is due to poor distribution of present stands with respect to the soda-pulp industry. Pennsylvania produces almost no aspen of satisfactory pulpwood size, yet consumed 81,000 cords in 1929. Maine, although importing nearly a fifth of its aspen pulpwood, finds its own stands in remote locations unmarketable. Up to 1922, the quantity of aspen used for pulp in the Lake States was trifling, in spite of the known presence of enough standing timber to support a permanent industry using probably 200 thousand cords a year; by 1929 the use had jumped to nearly 60 thousand cords, under the stimulus of availability. The lumber industry offers little, if any, competition to the pulp and paper industry in the use of aspen.

In contrast to the scarcity of spruce and fir—a scarcity which is now being met by huge imports of pulpwood, wood pulp, and paper from foreign countries—is the abundance within the New England, Middle Atlantic, and Lake States of species such as beech, birch, maple, and various pines, which are already classed as pulp species, but which are relatively little used in these regions. Full use of these species now available seems the most promising solution of the immediate problem of availability in the older pulp- and paper-producing regions. Research, both at the Forest Products Laboratory of the United States Forest Service and in commercial plants, has amply demonstrated the possibility of adapting pulping processes to their extensive use. Some of these possibilties have been discussed in Department of Agriculture Bulletin No. 1241, "How the United States Can Meet Its Present and Future Pulpwood Requirements."

Pacific Coast region.—The opportunity in the Pacific Coast region for still larger sulphite- and mechanical-pulp industries is based on supplies of virgin spruce, fir, and hemlock many times larger than those in any other forest region of the United States (table 5). Even larger stands of pine afford a similar opportunity to increase the production of sulphate pulp and the grades of paper, such as wrapping and boards, manufactured therefrom. This region also contains an abundance of available water power. Of the total potential horsepower estimated for the United States, about two fifths is in this region.

The fact that the pulp and paper industry in the Pacific Coast region must, to some extent at least, compete for raw material with a very large and well-developed lumber industry is not necessarily a disadvantage. There is no reason other than a lack of pulpwood markets why there should not be operations designed primarily to

secure pulpwood, or why operations in stands containing a large percentage of pulp species should not be designed to secure lumber from the material most suitable for that purpose and pulpwood from the remainder of the stands.

There are great possibilities in this region for the integration of the lumber and pulp and paper industries; in fact, in Washington, which ranks first in lumber production and fourth in pulp production, an approach to integration has already been made. Such integration would make feasible not only a more profitable utilization of saw-log material but also a large use of both logging and sawmill waste. Of the 956 thousand cords of pulpwood consumed in Washington in 1929, 387 thousand cords consisted of slabs or other sawmill waste. Logging operations in western Washington alone annually produce 500,000 cords of small and low-grade Douglas fir, western hemlock, Sitka spruce, and "true" fir logs which are difficult to dispose of profitably and which could doubtless be used more advantageously for pulp than lumber. It would be possible to draw from the areas logged over annually in western Washington an additional 500,000 cords, by taking out material but little smaller or but little more defective than that which is logged primarily for lumber. It is therefore possible to obtain 1 million cords of pulpwood annually in western Washington from operations designed primarily for lumber, without taking into account the possibility of utilizing the 3 million cords of material of cordwood size or larger left annually in the woods after logging in the form of small or broken timber.

South region.—The spruce-fir-hemlock timber of the South has less significance than similar amounts of the same species in either the New England, Middle Atlantic, or Lake regions (table 5). These stands, which occupy a relatively limited area on the higher slopes of the southern Appalachian Mountains, are estimated at less than 5 million cords, and the prospect that they will reproduce after commercial logging as now conducted is far less certain than in the more northerly regions.

As earlier described, the various stands of soda-pulp species—cottonwood, yellow poplar, birch, beech, maple, and gum—have for the most part been more or less heavily and repeatedly cut over in the past. Although cutting exceeds growth, there are undoubtedly many areas from which a large volume of pulpwood could be taken as thinnings and improvement cuttings; in fact, its removal might be made to constitute one step toward better forest management. With proper methods of forest management in the cutting, and thereafter, it should easily be possible for the South to take care of our present national requirement for soda-pulp timber and to enlarge production to absorb our increasing needs for years to come. Relatively small areas could, if worked for pulpwood alone, be made to produce the entire volume required.

For sulphate pulp, as shown by table 5, the Southern States from Virginia to Texas have a large supply of suitable timber and the additional advantage of easy access to the principal markets of the country. The South, moreover, is capable of reproducing stands of southern yellow pines suitable for pulping purposes in approximately 25 years, a rate impossible elsewhere in the country except in the Pacific Coast region.

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The rapid growth of a pulp and paper industry in the South during the past decade has undoubtedly been due in a large measure to an abundant supply of southern yellow pines. (Table 5.) The principal product at present is sulphate or kraft pulp. It has been found that a kraft pulp can be made from southern yellow pine that is quite as strong and as satisfactory iu texture as is obtained from other species and other localities. With the exception of a mill or two producing bleached book papers from the pines, the insulation and pressed-wood-board developments utilizing bagasse and pine sawmill waste, respectively, and several recently built "semichemical" pulping plants, all of the establishments in the South make this brown kraft pulp. The utilization of kraft for cement bags and similar containers has given this industry considerable impetus. The South now can be said to dominate the kraft pulp field.

The trend in the South at the beginning of the depression was toward a considerable enlargement of the kraft pulping industry. The cheap pulpwood, together with proper attention to the technical improvements necessary to produce pulps equal or superior to imported products, may well win the kraft market for southern producers. When it is considered that the United States imported 450 thousand tons of sulphate pulp in 1929, the possibilities for great development in the South without cutting in on present domestic production elsewhere can be realized.

The raw material for an indefinite expansion of the kraft industry in the South is even more readily available than that for expansion of the soda-pulp industry. There are over 100 million acres of southern pine lands, and even a tithe of their possible annual production of wood can supply not only the present American but the world demand for kraft papers. Moreover, should recent technical developments by the Forest Products Laboratory of the Forest Service be taken advantage of commercially, permitting the branching out of the industry or the development of lines other than brown pulps, the necessary timber is still abundantly available in this region.

It has been more than 10 years since the Forest Products Laboratory announced a method for the production of bleached book and magazine papers from southern yellow pines and gums. Ordinary kraft pulp is very difficult to bleach and the usual bleached product is of low strength. The new method involves the use of the sulphate or kraft process with certain modifications, but the chief point of difference is the use of a two-stage system of bleaching. The findings of this research are practiced by not more than one or two southern mills, and consequently only a small amount of book paper is at present made in the South. Elsewhere, however, progress in the two-stage bleaching practice has gone on apace. Savings made possible by this practice have resulted in the installation of two-stage systems in many pulp mills operating on spruce and hemlock. Thus, the practicability of the idea is established. Its intensive application to southern woods should make them available to the book-paper industry.

Another investigation had the objective of combining strength, heretofore lacking in bleached southern yellow pine papers, with lightness of color. Such a pulp is especially desirable since to a certain extent it would be a substitute for the sulphite pulp used in news-

print, wrapping papers, and bond. It was found that by modifying the sulphate process a better yield of southern yellow pine pulp could be obtained, also a pulp that could be bleached without serious loss of strength. The method has thus far been used only with loblolly and longleaf pine, but appears to be generally applicable to the other pines.

Concurrently with the study of the pines, the Forest Service has conducted experiments with the gums and other southern hardwoods. They have revealed that the sulphite process works satisfactorily with the gums, particularly black and tupelo gums, yielding a fairly strong pulp that bleaches easily to a blue-white color. It appears that a book paper can be made by a combination of bleached pine sulphate pulp and of bleached gum sulphite pulp. Most book papers contain bleached spruce sulphite along with soda pulp, which is usually made from aspen. The long-fibered pine sulphate would take the place of the spruce sulphite; and the gum sulphite, which would replace the soda pulp, would impart the blue-white color so greatly desired.

Another new development particularly suited to the reduction of the southern hardwoods, which was also worked out at the Forest Products Laboratory, is the so-called "semichemical process." It is employed by at least five plants in pulping extracted chestnut chips, a byproduct of tanning extract plants. Prior to 1925, these chips were used only as fuel, but with the advent of the new process they were successfully converted into corrugated paper stock. At another mill semichemical gum pulp is converted into machine-glazed wrapping papers of a light color. By a little more careful selection of the wood this mill could undoubtedly produce from gum a semichemical paper suitable for cheap print or tablet use. The semichemical process not only gives high yields of pulp, but also a pulp capable of considerable development as to strength. There is a possibility that semichemical pulp can to an extent take the place of the more expensive kraft paper, now used in the manufacture of pulpboard. It appears particularly promising for use in a mixture with kraft for container lining. In view of the already extensive development of the semichemical process in the South and its unquestioned possibilities, the very large quantity of gums and other hardwoods in the South should be considered available to the pulp and paper industry there.

North and south Rocky Mountain regions.—These two western regions afford an opportunity for enlarged sulphite and mechanical pulp operations, but to a much smaller degree than the Pacific Coast region or Alaska. They afford a similar opportunity for sulphate pulp, but here also in much smaller degree than in the Pacific Coast region or the South. The opportunity in both cases is based, as in Alaska and the Pacific Coast region, on remaining supplies of virgin timber. (Table 5.) At present, the industry is less developed in the Rocky Mountain States than in any other forested region of the United States.

Alaska.—Our pulpwood resources are not confined to the 48 States. Southeastern Alaska, in fact, is one of the two outstanding regions with large virgin stands of softwoods adapted for sulphite and mechanical pulps. As compared with western Oregon and Washington, southeastern Alaska has the advantage of practically pure stands of spruce and hemlock, lower stumpage prices, and cheaper power.

It has the disadvantage of being considerably farther from the large paper markets, and of pioneer conditions which would tend to hamper the development of an industry. In southeastern Alaska, cutting operations for lumber and other purposes are very small, so that in this respect there would be a greater opportunity for the development of a dominant pulp and paper industry than in any of the Western States.

Southeastern Alaska is within the range of the extensive Pacific Coast forest, which occurs in western Oregon, Washington, and British Columbia and along the southern coast of Alaska as far north and west as the Aleutian Peninsula and Afognak Island. It is essentially a timber-producing region. Aided by mild temperature and abundant rainfall, the region supports extensive stands of rapidly growing trees; because of rough topography and thin soil, perhaps less than 1 percent of the area is suitable for farming. In view of the high latitude, an outstanding climatic feature is the mild winter temperatures. There are no climatic factors which prevent or seriously hinder the operation of wood-working establishments throughout the year.

Nearly all the land in southeastern Alaska is owned by the Federal Government, and nearly 17 million acres, or 73 percent, has been included in the national forest system to be administered primarily for continuous production of timber crops and a sustained yearly output of raw material for local wood-using industries. Of the 17 million acres only 3 million acres bears commercial timber.

There is little timber in private ownership in southeastern Alaska. All but about 1½ billion board feet is in the Tongass National Forest. The volume of commercial timber in the Tongass National Forest is estimated as follows:

	Board feet
Western hemlock	58, 000, 000, 000
Sitka spruce	15, 800, 000, 000
Western red cedar	2, 350, 000, 000
Alaska cedar	2, 350, 000, 000
Total	78, 500, 000, 000

The western hemlock and Sitka spruce stands are characteristically even aged. Many age classes are represented in the forest as a whole, but the older classes are greatly in the majority, with perhaps three fourths of the commercial timber of the region mature or overmature.

Although this 78.5 billion board feet of commercial timber averages about 26 thousand board feet per acre, individual logging units vary widely from this average. A volume of 30 to 40 thousand board feet per acre is common on many extensive areas, and 50 thousand feet or more per acre is not unusual on small units. The majority of the merchantable trees are from 24 to 48 inches in diameter and from 90 to 140 feet high.

The commercial forests extend from tidewater to an elevation of about 1,500 feet. Because of prevailing steep slopes, they form relatively narrow bands along the shore lines of the mainland and islands, rarely extending inland more than 5 miles, except along the valleys of the few large streams. A large percentage of the timber can be logged directly to tidewater by the use of 2 or 3 logging engines working tandem. Floating logging camps, easily towed from one

cutting area to another, are in general use. Similarly, donkey engines and all logging equipment are moved on scows and floats.

The extensive forest resources of southeastern Alaska are likely to be exploited chiefly for the manufacture of newsprint paper, because of the favorable conditions there for large-scale operations that now characterize that industry. Conditions are not so good, however, for other branches of the paper industry, or for the extensive manufacture of lumber.

It is estimated that the forests of southeastern Alaska, under a proper system of management, can produce in the neighborhood of 1½ million cords of pulpwood annually in perpetuity. Converted into newsprint this represents a production of 1 million tons, or more than one fourth of the present yearly consumption of newsprint in the United States.

NAVAL-STORES TIMBER

Under the general term "Naval Stores" are included turpentine and rosin. In the United States these two commodities are all derived from longleaf and slash pine timber in the group of States from North Carolina to Texas. About 87 percent of the product is manufactured from the gum gathered from the living pine tree and is known as gum turpentine and rosin. The remaining 13 percent is distilled from the pitchy stumps and down wood left after logging, and is known as wood turpentine and rosin. In considering the availability of naval-stores resources these two sources of naval stores must be kept in mind.

The longleaf-slash pine forests of the South are now almost entirely second growth; of the total area of this type of forest only about 5 percent is old-growth timber. The naval-stores belt embraces the entire type, which extends in a broad band from central North Carolina southwestward, parallel to the coast, through North and South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, and eastern Texas. (Fig. 2 of section, "Forest Land the Basic Resource.") Of the total area of nearly 52 million acres, it is estimated that 27 percent is either denuded or unsatisfactorily restocked; 5.6 percent is old-growth saw timber; and the remainder, or 67.4 percent, is in second-growth longleaf and slash pine stands of varying ages, sizes, and degrees of stocking. The 35 million acres or so which the existing young stands cover is mainly in Georgia and Florida.

The area of greatest production is even smaller. Over 80 percent of American gum naval stores is now produced from a forest area of approximately 13 million acres in southeast Georgia and north Florida, where the timber is almost entirely second growth. The chief reason for this concentration of the industry on only about a quarter of the total area in the naval-stores belt is that in this region the young growth has more uniformly restocked the cut-over land and has had more time to grow to workable size than elsewhere. The devastated areas and the areas that are not restocking satisfactorily are found to a greater extent in the more recently cut-over lands in Mississippi, Louisiana, and Texas.

Almost no naval-stores timber is inaccessible to operation. Although there is, of course, a lower limit to the number of trees per acre which it is profitable to turpentine, yet, if site quality and other conditions are such that any second growth at all comes up, the result

is generally the establishment of a stand dense enough to work at a profit. A far more important limiting factor is the average size of the timber.

The available old-growth stands and the larger trees in the oldest second-growth stands have been or are now being worked for turpentine. As to future crops of naval-stores timber, almost all that is known of the approximately 35 million acres of second growth is that it includes stands generally varying in age from 1 to 30 years, and in degree of stocking from 1/10 up. Little data are available, as to the exact proportion of the various size classes of young growth, upon which to base any reliable prediction of the supply of timber for future operations. In many sections of the naval-stores belt there seems to be a shortage in the 4-inch to 6-inch diameter classes, upon which the gum industry must depend largely for its new cupping material in the near future. It is generally believed that there may be a lack of timber of turpentine size for a short while ahead, probably the next decade. However, there is now growing in the naval-stores belt a sufficiently large number of young trees in the 2-inch to 4-inch diameter classes to maintain, when it has grown to workable size, an industry of the present size.

Thus, so far as permanence of timber supply is concerned, the future of the gum naval stores industry seems assured, provided that a sane policy of forest protection and management is followed. There is sufficient land and there will be ample regrowth of the timber if nature is not handicapped by wholesale uncontrolled burning in regeneration areas. Moreover, under improved methods of operation and timber management already known to the industry, the timber when grown to workable size can be made to produce more gum at smaller cost and with less loss of the residual lumber value than under current methods.

The possible shortage of timber suitable for cupping in the near future is not a serious check to the industry as a whole, nor is it likely to result in any material shortage of naval stores products, even temporarily. In the first place, a large surplus or accumulation of stocks is already on hand and must be absorbed during the next few years; in the second, the wood naval-stores industry may be capable of increasing its output sufficiently to bridge whatever shortage may develop in gum naval-stores production. The amount of pine stumps and retort wood from which wood naval stores are derived appears to be ample to meet the demands of this branch of the industry for years to come.

Character of ownership has had a very profound effect upon the conduct of the industry. One of the great difficulties under which the industry labors, in common with other natural-resource industries, has been overproduction. The capital required to establish a turpentine still is relatively small, and even a slight rise in the price of naval stores has encouraged new stills to start operation. Studies by the Southern Forest Experiment Station and other branches of the Forest Service have thoroughly established the fact that the smaller trees in a stand are turpentined at a loss. But it is almost impossible to persuade a large number of small landowners that they will profit by leaving their small timber unturpentined. If the timber were more strongly held, the small trees would be kept off the market, and the entire industry would profit in the long run. The factors who finance

most of the naval-stores operations have the best opportunity to encourage good practice and put the industry on a better basis. They are usually to be found on the side of progressive ideas in turpentine practice and in favor of timber conservation.

The American production of naval stores is about twice the domestic consumption. Moreover, 80 percent of it is being obtained from only about one quarter of the total forest area adapted to naval-stores production. It seems therefore that, so far as the American consumer of turpentine and rosin and other derived products of the naval-stores industry is concerned, the prospective timber supplies are more than adequate to meet our requirements. It would be a great mistake, however, to view the naval-stores situation purely from the point of view of our national requirements and to ignore the consequences of a possible shrinkage of the industry to a point where it would be capable of satisfying only American needs. A permanent naval-stores industry of present or greater size would give steady employment to a very large local population in the pine woods of the South. It would be the means of keeping in highly productive use great areas of land not adapted to agriculture, and would therefore contribute materially to a well-rounded program of land use. From every point of view the naval-stores industry, as an industry, independent of this country's direct need of the product obtained, is a distinct asset to the United States.

The present magnitude of our naval-stores industries and the possibilities of an even larger industry in the future make wise management of this resource a matter of public welfare. To plan for such management, however, adequate information must be available. At present, comprehensive data on the extent, character, and availability of naval-stores timber in the South are quite lacking. In fact, the outstanding need in the naval stores belt for both the gum and the wood naval-stores industries, as well as timberland owners generally, financiers, lawmakers, and State and county administrators, is an immediate inventory of forest resources and a survey of the industrial situation from all angles.

The permanence and future welfare of the naval-stores industries themselves depend in no small measure on an accurate knowledge of fundamental conditions. The industry has benefited enormously by the campaign against uncontrolled forest fires which was begun comparatively recently in the Southern States. But it must have far better information than it has now on a number of other vitally important matters before it can put its house fairly in order.

As a producer of wealth and as a field for labor, the naval-stores industry is an important factor in the economic life of the South. Many economists consider it the economic key to the successful reforestation of much of the forest land in the South. That it must be given great weight in any balanced land-use program in the States embraced in the naval-stores belt is not questioned.

FOREST DRAIN

In any analysis of our forest resources, a fundamental consideration is that of current forest drain, or the volume of material removed from the forests annually by cutting and by fire, insects, disease, and other destructive agencies. Of equal importance are estimates of annual growth, and of the relation between drain and growth, treatment of

which will follow. The present discussion will be confined to the important aspects of the situation as to forest drain.

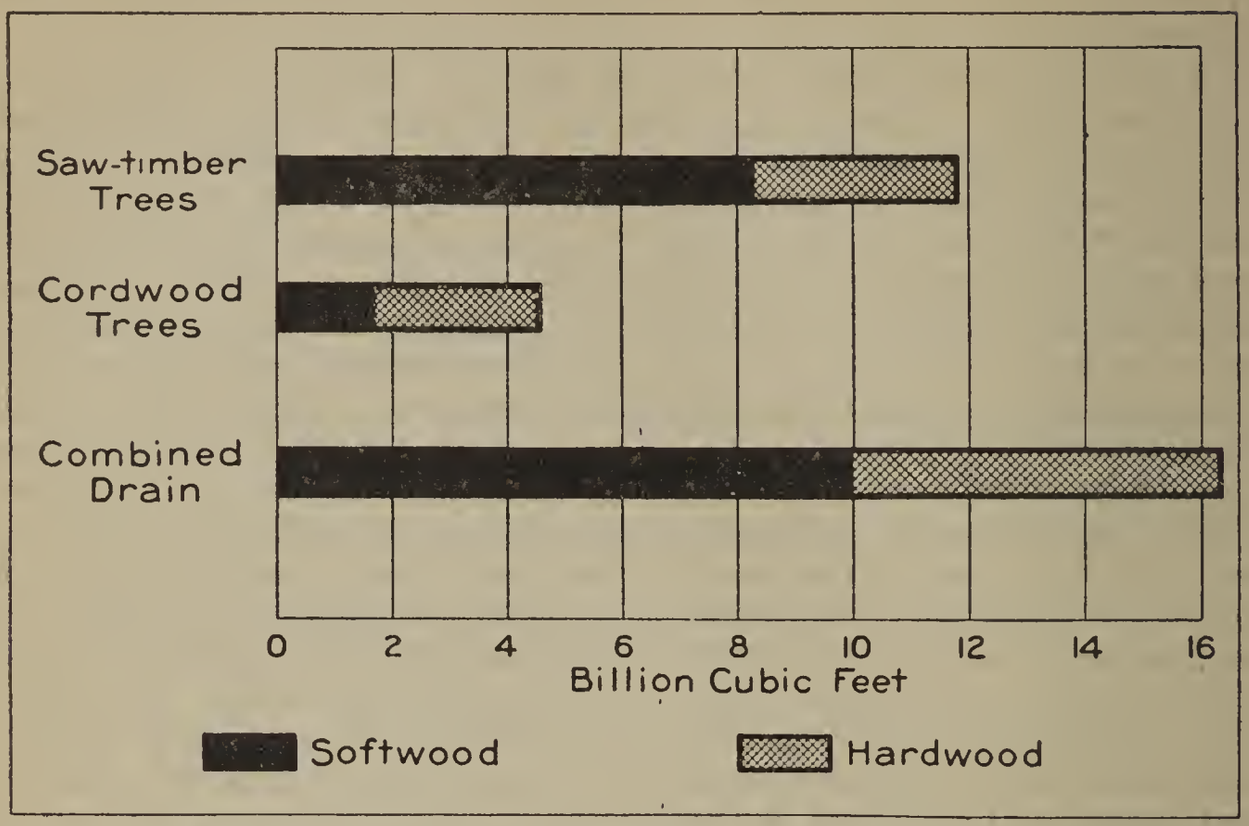

FIGURE 10.—Drain (cut and losses) on the commercial forests of the United States by character of growth and class of wood.

The estimate of present annual drain on the commercial standing timber in the United States is more than 16 billion cubic feet (table 10

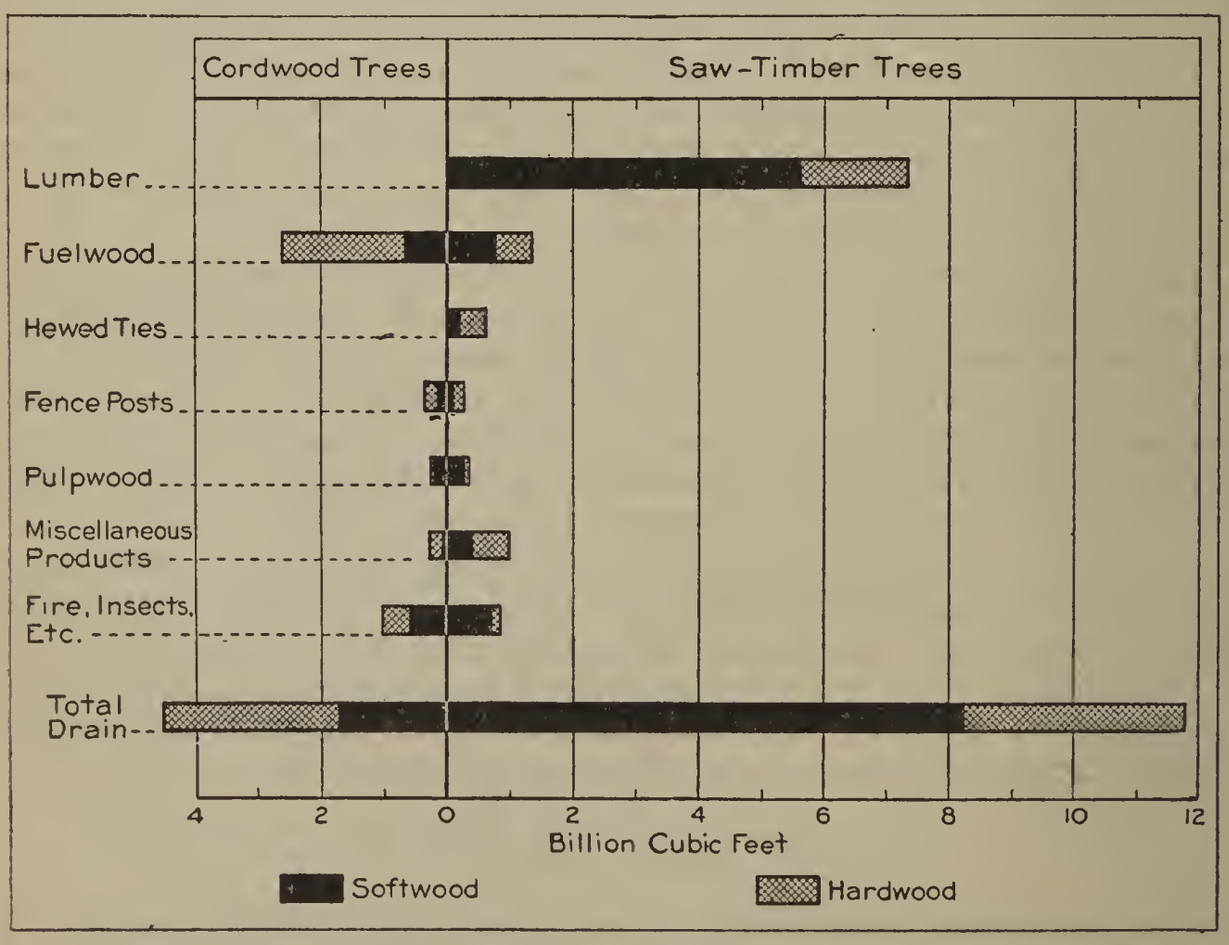

FIGURE 11.—Drain on the commercial forests of the United States through use or loss from destructive agencies, shown by character of growth and class of wood.

and figs. 10 and 11). In this total, the figures for timber cut are based upon the average quantity of commodities produced from domestic

timber during the years 1925 to 1929, inclusive. This period was chosen as covering the years for which more and better statistics were available than for any other recent period. It avoids not only the subnormal swing of the economic depression, but also the earlier trends that are out of line with present-day production. The drain averages thus obtained represent merely the conditions for these years and are not necessarily to be considered as an index of future wood requirements.

Timber destroyed includes only large-scale timber losses, not salvaged, over and above the normal losses through the death and decay of individual trees, for which allowance is made in estimating growth. Losses other than those from fire and naval-stores operations are averaged for the period 1920 to 1929, instead of 1925–29, the longer period permitting the inclusion of a greater number of less frequent, cataclysmic disturbances and thus insuring a better average figure.

TABLE 10.—*Total timber cut or destroyed each year in the commercial forests of the United States, by agencies* [1]

Agency	All timber			Saw-timber trees		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	M cu. ft.	*M cu. ft.*	*M cu. ft.*	*M ft. b.m.*	*M ft. b.m.*	*M ft. b.m.*
Timber cut [2]	14,495,308	8,683,886	5,811,422	54,641,444	40,228,682	14,412,762
Fire losses [3]	870,690	601,490	269,200	1,390,233	1,250,948	139,285
Other losses [4]	985,209	697,111	288,098	3,402,162	3,075,284	326,878
All agencies	16,351,207	9,982,487	6,368,720	59,433,839	44,554,914	14,878,925

Agency	Cordwood trees		
	Total	Softwood	Hardwood
	Cords	*Cords*	*Cords*
Timber cut [2]	35,486,179	11,141,362	24,344,817
Fire losses [3]	6,903,718	4,231,994	2,671,724
Other losses [4]	4,081,362	1,742,426	2,338,936
All agencies	46,471,259	17,115,782	29,355,477

[1] For definiation, explanations, and general make-up of this table see footnotes in subsequent timber-loss tables and also refer to text.
[2] Timber cut annually, 1925 to 1929, inclusive.
[3] Timber killed annually by fire and not utilized, 1925 to 1929, inclusive.
[4] Timber killed annually by insects, disease, drought, wind, naval-stores operations, etc., and not utilized, 1920 to 1929, inclusive.

The total drain figure of 16 billion cubic feet (table 10) is in contrast with that of 26 billion cubic feet estimated by the Forest Service in 1920 in the report on Senate Resolution 311, on the basis of the 1910–19 period. The differences between the two estimates are due in part to the decrease in the use of wood for fuel from 110 million cords in the 1920 estimate to 61 million in the present estimate. Elimination of bark (as in the case of the timber stand and growth estimates) and the use of improved conversion factors also had the effect of reducing the present estimate. The present figure for saw-timber drain (59 billion board feet) is actually larger than the 1920 estimate (56 billion feet), because of the different and improved methods employed in making the estimate.

As indicated in table 10 and figure 12, cutting accounts for 89 percent of the total, fire for 5 percent, and disease, insects, etc., for 6 percent. Seventy percent of the total drain is represented by the 59 billion board feet (11½ billion cubic feet) that comes out of saw-timber trees (table 11 and figure 11), of which 55 billion board feet is taken by the annual timber cut.

The total drain on saw timber is about five times, and on total timber volume nearly twice, the estimated current annual growth. It may be correctly inferred from this that the forest resources of this country are being seriously depleted. The national situation, however, is a complex of regional situations which vary widely as to the relation between drain and growth. An adequate understand-

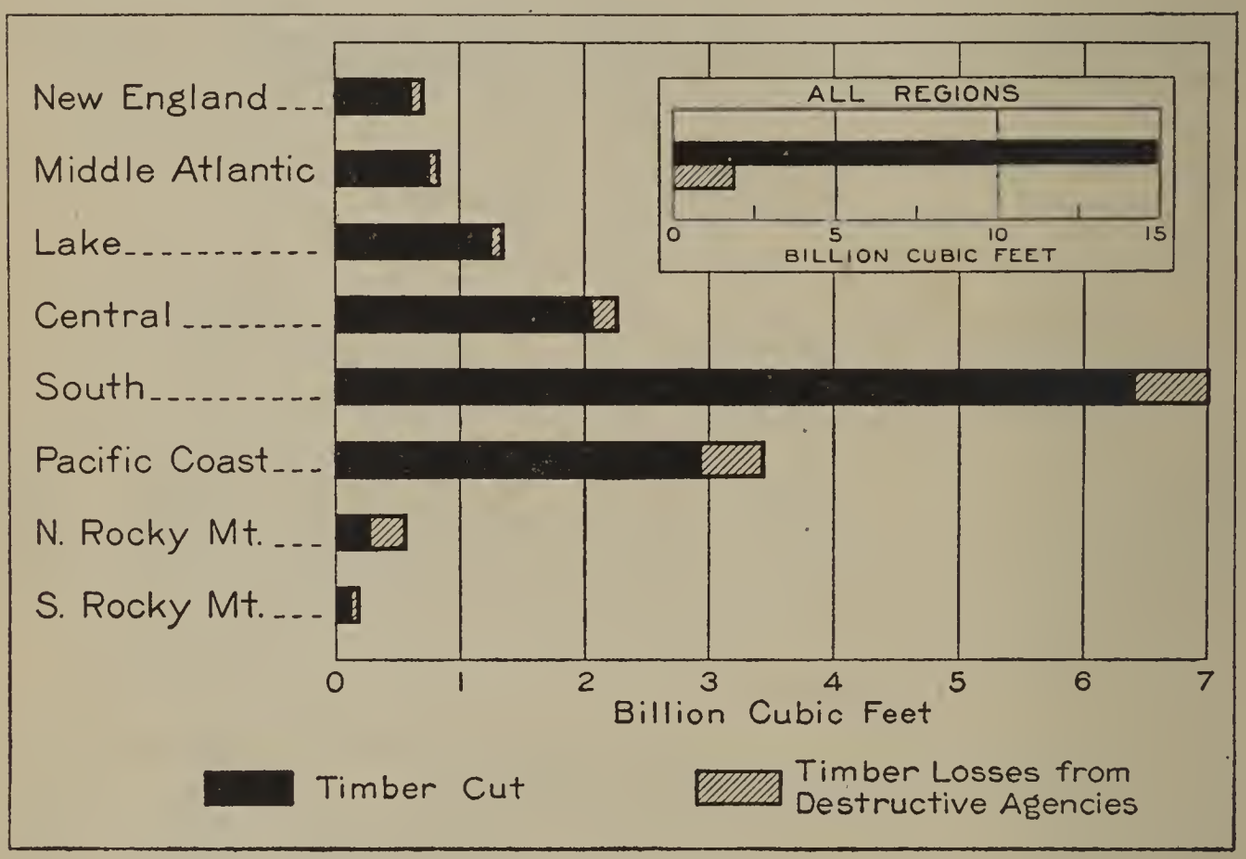

FIGURE 12.—Total drain on the commercial forests of the United States by regions.

ing of the matter can be had only by a more detailed consideration of this complex, such as is given in other pages of this section.

TABLE 11.—*Total timber cut or destroyed each year in the commercial forests of the United States, by regions* [1]

Region	All timber				Saw-timber trees	
	Total		Softwood	Hardwood	Total	
Eastern regions:	*M cu. ft.*	*Percent*	*M cu. ft.*	*M cu. ft.*	*M ft. b. m.*	*Percent*
New England	706,010	4	362,657	343,353	1,904,797	3
Middle Atlantic	835,077	5	145,081	689,996	1,082,885	2
Lake	1,343,360	8	492,780	850,580	2,747,810	5
Central	2,263,087	14	250,310	2,012,777	5,525,089	9
South	7,011,589	43	4,557,136	2,454,453	26,339,261	44
Total	12,159,123	74	5,807,964	6,351,159	37,599,842	63
Western regions:						
Pacific Coast	3,444,011	21	3,427,113	16,898	18,799,052	32
North Rocky Mountain	566,328	4	566,247	81	2,377,634	4
South Rocky Mountain	181,745	1	181,163	582	657,311	1
Total	4,192,084	26	4,174,523	17,561	21,833,997	37
All regions	16,351,207	100	9,982,487	6,368,720	59,433,839	100

[1] Combined average annual drain; cutting, 1925 to 1929, inclusive; fire losses, 1925 to 1929, inclusive; insects, disease, drought, wind, naval stores operations, etc., 1920 to 1929, inclusive. For definitions, explanations, and general make-up of this table see footnotes in subsequent timber-loss tables and also refer to text.

TABLE 11.—*Total timber cut or distroyed each year in the commercial forests of the United States, by regions*—Continued

Region	Saw-timber trees		Cordwood trees			
	Softwood	Hardwood	Total		Softwood	Hardwood
Eastern regions:	*M ft. b.m.*	*M ft. b.m.*	*Cords*	*Percent*	*Cords*	*Cords*
New England	1,514,441	390,356	3,120,456	7	455,587	2,664,869
Middle Atlantic	350,620	732,265	6,089,097	13	720,661	5,368,436
Lake	1,328,977	1,418,833	7,110,679	15	1,909,843	5,200,836
Central	982,937	4,542,152	10,638,875	23	579,691	10,059,184
South	18,595,540	7,743,721	16,100,004	35	10,106,455	5,993,549
Total	22,772,515	14,827,327	43,059,111	93	13,772,237	29,286,874
Western regions:						
Pacific Coast	18,749,881	49,171	1,581,705	3	1,514,339	67,366
North Rocky Mountain	2,377,264	370	1,406,136	3	1,406,136	
South Rocky Mountain	655,254	2,057	424,307	1	423,070	1,237
Total	21,782,399	51,598	3,412,148	7	3,343,545	68,603
All regions	44,554,914	14,878,925	46,471,259	100	17,115,782	29,355,477

The ratio of drain to stand in hardwood saw timber is nearly three times that for softwood saw timber. Similarly, in total volumes,

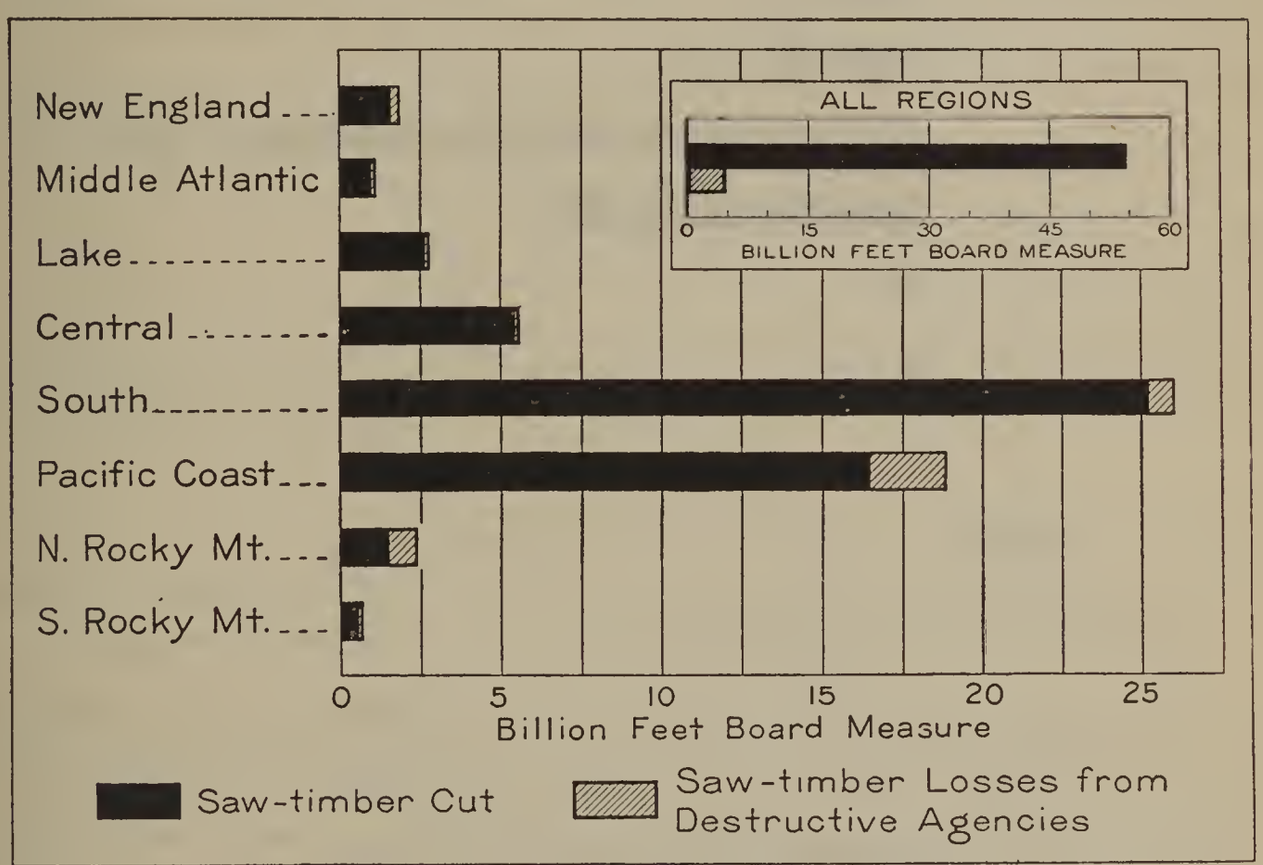

FIGURE 13.—Total saw-timber drain on the forests of the United States by regions.

the hardwood ratio is about two times. This is consistent with the generally known fact that depletion is proceeding more rapidly in the hardwoods than in the softwoods, and that the problem of adequate hardwood supplies is more acute.

In annual drain (in cubic feet) for all classes of timber (table 11 and fig. 12) the forests of the East account for three times as much as those of the West; more than half of the volume of the eastern cut is from hardwoods, while that from western hardwoods is insignificant. The large excess of the South over the Pacific coast consists principally of hardwood saw timber and cordwood trees. Total southern drain is

about three times that of the Central States but here the excess is very largely in the softwood saw-timber trees. The saw-timber drain in the South (in board feet) is also much higher than that in the Pacific-coast region (fig. 13), but the difference is not so great as in the comparison of drain for all classes of timber, because of the fact that saw timber comprises a larger proportion of the total drain in the Pacific-coast region. These facts further emphasize the important place which the South holds in the forest affairs of the country, but they also show that, in the relation of forest depletion to softwood timber stands, the Pacific Coast is in a far more favorable position.

TIMBER CUT

The United States is by far the largest consumer of wood in the world. Although imports of forest products into the United States

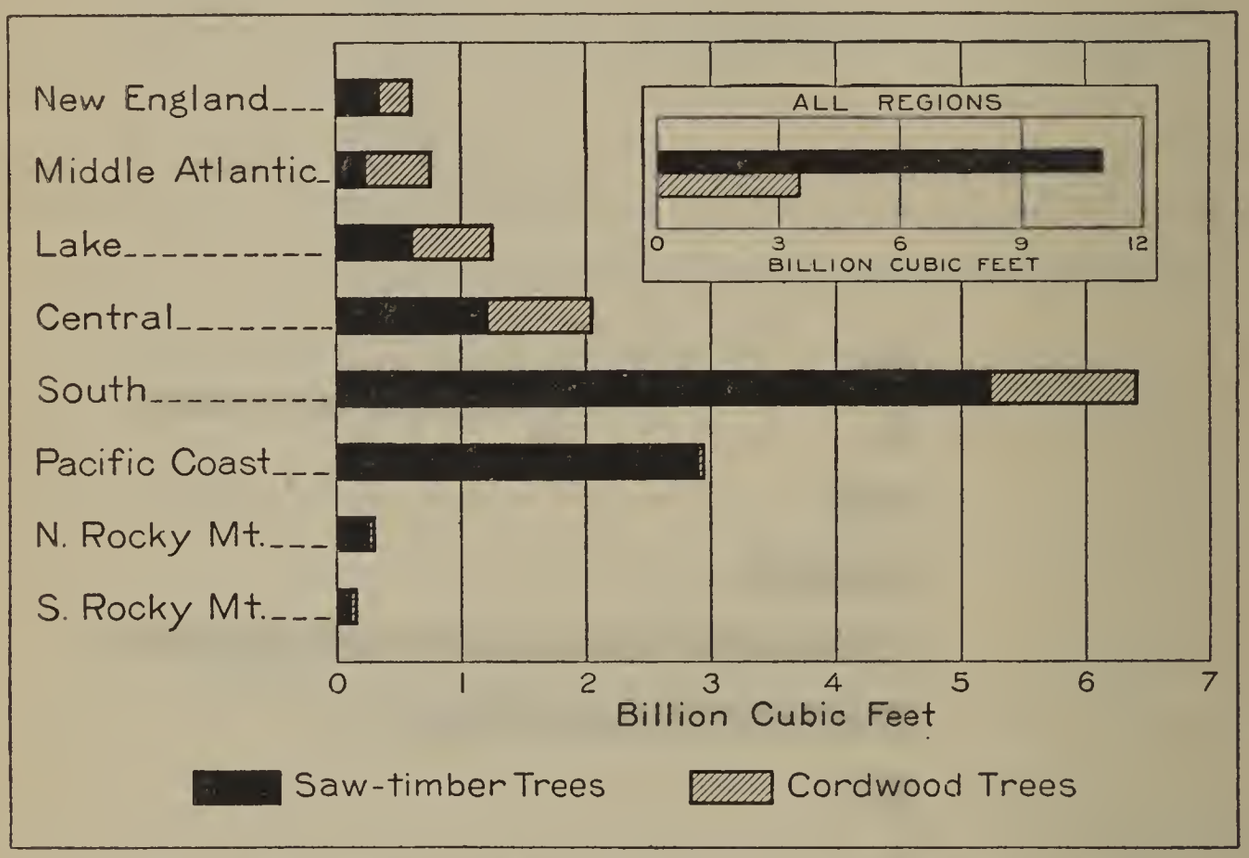

FIGURE 14.—Total timber cut on the forests of the United States by tree size and region.

are larger, as a whole, than exports, both are comparatively small, so that United States consumption (with the rather notable exception of pulpwood) is closely reflected by the timber cut of the United States.

The annual cut from saw-timber trees and from smaller trees in the United States amounts to about one half and one sixth, respectively, of the world's consumption. The combined United States cut of 14½ billion cubic feet (table 12) is about one third of the world consumption. Three fourths of the world's saw-timber consumption and half of the total wood consumption is softwood. In the United States 74 percent of the saw timber and 60 percent of the combined timber cut is softwood. The per capita cut of the United States is estimated to be 118 cubic feet, of which 89 cubic feet (445 board feet), or 75 percent, is from trees of saw-timber size.

Table 13 shows the proportion of timber drain represented by the most important commodities produced from saw timber and cordwood trees separately and combined (figs. 14 and 15).

TABLE 12.—*Timber cut each year in the commercial forests of the United States, by regions* [1]

Region	All timber				Saw-timber trees	
	Total		Softwood	Hardwood	Total	
Eastern regions:	*M cu. ft.*	*Percent*	*M cu. ft.*	*M cu. ft.*	*M ft. b.m.*	*Percent*
New England	619, 147	4	293, 503	325, 644	1, 647, 827	3
Middle Atlantic	771, 592	6	131, 618	639, 974	1, 061, 559	2
Lake	1, 266, 825	9	469, 049	797, 776	2, 708, 807	5
Central	2, 066, 846	14	239, 387	1, 827, 459	5, 453, 791	10
South	6, 417, 934	44	4, 214, 926	2, 203, 008	25, 232, 821	46
Total	11, 142, 344	77	5, 348, 483	5, 793, 861	36, 104, 805	66
Western regions:						
Pacific Coast	2, 937, 390	20	2, 920, 492	16, 898	16, 486, 839	30
North Rocky Mountain	287, 190	2	287, 109	81	1, 510, 140	3
South Rocky Mountain	128, 384	1	127, 802	582	539, 660	1
Total	3, 352, 964	23	3, 335, 403	17, 561	18, 536, 639	34
All regions	14, 495, 308	100	8, 683, 886	5, 811, 422	54, 641, 444	100

Region	Saw-timber trees		Cordwood trees			
	Softwood	Hardwood	Total		Softwood	Hardwood
Eastern regions:	*M ft. b.m.*	*M ft. b.m.*	*Cords*	*Percent*	*Cords*	*Cords*
New England	1, 284, 467	363, 360	2, 722, 673	8	191, 934	2, 530, 739
Middle Atlantic	348, 798	712, 761	5, 436, 526	15	576, 039	4, 860, 487
Lake	1, 321, 233	1, 387, 574	6, 273, 311	18	1, 676, 205	4, 597, 106
Central	980, 500	4, 473, 291	8, 628, 934	24	465, 105	8, 163, 829
South	17, 808, 643	7, 424, 178	11, 827, 417	33	7, 703, 364	4, 124, 053
Total	21, 743, 641	14, 361, 164	34, 888, 861	98	10, 612, 647	24, 276, 214
Western regions:						
Pacific Coast	16, 437, 668	49, 171	307, 172	1	239, 806	67, 366
North Rocky Mountain	1, 509, 770	370	133, 983	(2)	133, 983	
South Rocky Mountain	537, 603	2, 057	156, 163	1	154, 926	1, 237
Total	18, 485, 041	51, 598	597, 318	2	528, 715	68, 603
All regions	40, 228, 682	14, 412, 762	35, 486, 179	100	11, 141, 362	24, 344, 817

[1] Average for years 1925 to 1929, inclusive. Basic data from reports of the Census of Manufactures, the Forest Service, and information supplied by State and commercial organizations. For definitions, explanations and general make-up of this table, see footnotes in subsequent timber-loss tables and also refer to text.
[2] Less than one half of 1 per cent.

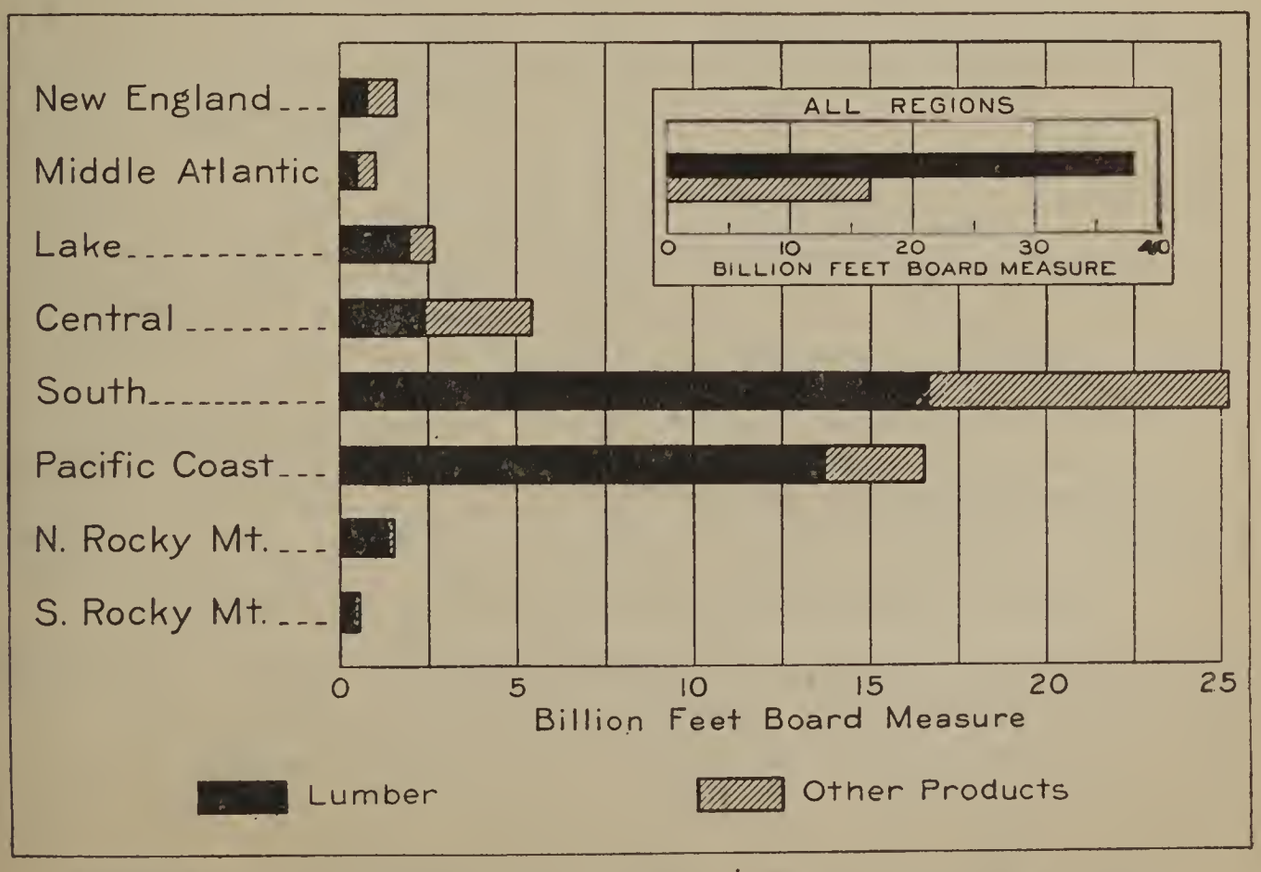

FIGURE 15.—Total saw-timber cut on the forests of the United States by use and region.

LUMBER

Lumber stands out as by far the most important single commodity into which the timber cut of this country enters. It accounts annually for 70 percent (38 billion board feet) of the saw-timber cut, and for

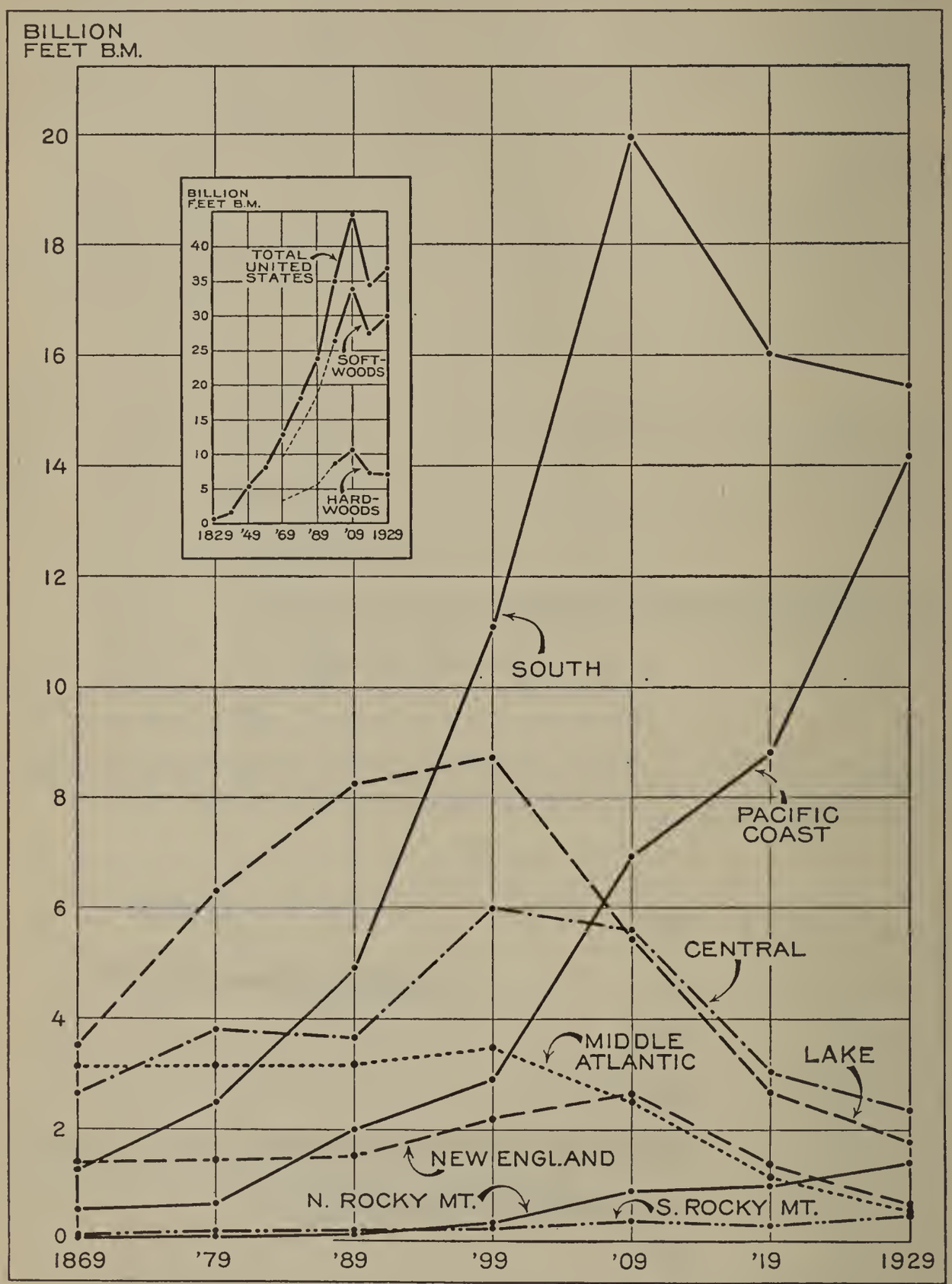

FIGURE 16.—Lumber production in the United States by regions 1869–1929.

about 50 percent (7 billion cubic feet) of the total cut. About four fifths of this huge lumber production is softwood (table 13).

The fact that lumber has long been our most important timber product is significant. It points to production of saw-timber as the major object of forest management. This, in turn, means long-rotation ages with all that that implies in complexities of

management, particularly in private ownership where in many cases the forest capital is so depleted or so inaccessible as to render long periods of waiting and large expenditures necessary before revenues can commence to come in on a sustained basis and at a rate in keeping with the potential producing capacity of the land.

The present relative distribution of our lumber cut, as well as the historical trend of the cut regionally, is shown by table 14 and figures 15 and 16. The Lake, Central, and Middle Atlantic regions were the most important lumber-producing regions in 1869, and at that time each was cutting 2½ billion board feet or more. The Lake continued prominent, reaching its peak in the early nineties, although surpassed shortly thereafter by the rapidly expanding cut in the South.

TABLE 13.—*Timber cut each year for commodity use in the commercial forests of the United States, by items* [1]

Item	Unit	Commodity production: Quantity [2] Total	Commodity production: Quantity [2] Softwood	Commodity production: Quantity [2] Hardwood	Timber cut (commodity drain) [3]: Total volume in cubic feet [4] Total	Total volume in cubic feet [4] Softwood	Total volume in cubic feet [4] Hardwood	Saw-timber trees [5] Total	Saw-timber trees [5] Softwood	Saw-timber trees [5] Hardwood	Cordwood trees [6] Total	Cordwood trees [6] Softwood	Cordwood trees [6] Hardwood
		Thousands	*Thousands*	*Thousands*	*Thousand cubic feet*	*Thousand cubic feet*	*Thousand cubic feet*	*Thousand feet board measure*	*Thousand feet board measure*	*Thousand feet board measure*	*Cords*	*Cords*	*Cords*
Lumber	Foot board measure.[7]	38,000,000	30,957,920	7,042,080	7,371,372	5,668,700	1,702,672	38,000,000	30,957,920	7,042,080			
Fuelwood	Cords	61,266	22,511	38,755	4,002,635	1,485,135	2,517,500	7,047,000	4,146,000	2,901,000	27,723,840	7,291,200	20,432,640
Hewed ties	Pieces	53,215	22,078	31,137	633,034	232,491	400,543	2,025,165	835,553	1,189,612			
Fence posts	do	395,946	138,503	257,443	628,836	278,438	350,398	1,299,459	654,438	645,021	3,641,342	1,615,345	2,025,997
Pulpwood	Cords	5,336	4,726	610	588,666	521,908	66,758	1,473,620	1,316,815	156,805	2,084,080	1,827,120	256,960
Mine timbers (round).	Cubic feet	184,875	37,509	147,366	231,780	47,530	184,250	155,988	43,626	112,362	1,692,152	325,437	1,366,715
Veneer logs	Foot board measure.[8]	920,034	293,882	626,152	230,607	59,601	171,006	1,033,708	332,691	701,017			
Slack staves	Pieces	979,610	360,970	618,640	109,345	33,863	75,482	487,861	179,780	308,081			
Slack heading	Sets	67,766	43,310	24,456	42,452	24,701	17,751	203,016	129,737	73,279			
Slack hoops	Pieces	138,939		138,939	10,053		10,053	41,626		41,626			
Logs and bolts in manufactures.	Foot board measure.[8]	593,328	92,393	500,935	156,575	20,790	135,785	677,960	109,443	568,517			
Tight staves	Pieces	307,167	149,921	157,246	97,116	39,414	57,702	460,378	224,822	235,556			
Tight heading	Sets	26,609	9,888	16,721	43,733	13,047	30,686	199,372	74,138	125,234			
Shingles	Pieces	6,298,100	6,298,100		138,558	138,558		629,810	629,810				
Export logs and hewn timbers.	Foot board measure.[8]	307,570	289,670	17,900	60,514	55,611	4,903	340,535	320,503	20,032			
Poles	Pieces	3,443	2,790	653	37,571	31,894	5,677	149,374	131,859	17,515	43,679	31,955	11,724
Distillation wood	Cords	1,283	434	849	36,367	4,294	32,073	88,970	11,300	77,670	204,870	22,600	182,270
Piling	Pieces	1,363	912	451	28,978	21,125	7,853	141,527	108,497	33,030	13,866	13,205	661
Tanning extract wood.	Cords	418		418	26,173		26,173	118,950		118,950	37,600		37,600
Excelsior wood	do	179	58	121	20,943	6,786	14,157	67,125	21,750	45,375	44,750	14,500	30,250
Total, all items.					14,495,308	8,683,886	5,811,422	54,641,444	40,228,682	14,412,762	35,486,179	11,141,362	24,344,817

[1] Based upon the average quantity of commodities produced from domestic timber during the years 1925 to 1929, inclusive, as shown under "commodity production."

[2] Estimated number of units produced for each item listed, excluding production from sawmill waste and imported logs, but including production from logging waste as well as from noncommercial forests. Items in cords include the bark in large part. Basic data from reports of the Census of Manufactures, the Forest Service, and information supplied by State and commercial organizations.

[3] Includes only the timber cut on commercial forest areas. The quantities were computed by converting the "commodity production" quantities into terms of "timber cut". Allowance was made for the fact that some items, including fuel-wood, posts, pulpwood, distillation wood and tanning extract material, are produced partly from so-called logging waste; and fuel-wood, ties, posts, mine timbers and poles partly from timber grown on noncommercial areas.

[4] Total quantity of timber cut from the commercial forests, including both saw-timber and cordwood trees. The volumes, necessarily shown in cubic feet, include the tops (cordwood size and larger) of the softwood saw-timber trees, and the tops and limbs of the hardwood saw-timber trees. Bark is not included.

[5] Includes only timber of saw-timber size. The volumes, in board feet, are equivalent to the lumber which could have been sawed from such trees.

[6] Includes only the merchantable volume, in cords, of trees below saw-timber size, in saw-timber, cordwood, and restocking areas.

[7] Lumber tally measure.

[8] Log scale measure.

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TABLE 14.—*Lumber production in the United States by regions, 1869–1929* [1]

[Million feet board measure]

Year	All regions	New England	Middle Atlantic	Lake	Central	South	Pacific Coast	North Rocky Mountain	South Rocky Mountain
1869	12,756	1,401	3,156	3,592	2,698	1,288	558	14	49
1879	18,091	1,460	3,187	6,278	3,821	2,498	664	39	144
1889	23,842	1,527	3,198	8,251	3,714	4,847	2,028	117	160
1899	35,078	2,204	3,506	8,750	6,011	11,116	2,901	321	269
1909	44,510	2,668	2,529	5,476	5,625	19,973	6,916	954	369
1910	40,018	1,969	1,985	5,030	4,752	17,432	7,448	1,065	337
1911	37,003	1,863	1,772	4,714	4,298	15,965	7,087	994	310
1912	39,158	1,981	1,732	4,424	4,387	18,118	7,239	986	291
1913	38,387	1,672	1,425	3,866	3,953	18,312	7,893	1,011	255
1914	37,346	1,966	1,587	3,918	3,634	17,801	7,082	1,081	277
1915	37,012	2,115	1,660	3,410	3,705	17,980	6,770	1,105	267
1916	39,807	1,823	1,292	4,050	3,336	19,617	8,136	1,233	320
1917	35,831	1,462	1,026	3,525	2,683	17,165	8,570	1,110	290
1918	31,890	1,412	961	3,220	2,513	13,775	8,590	1,143	276
1919	34,552	1,418	1,166	2,692	3,038	16,078	8,818	1,053	289
1920	33,799	1,138	1,060	2,386	2,754	14,362	10,355	1,380	364
1921	26,961	1,029	768	1,647	1,793	13,530	7,215	757	222
1922	31,569	790	634	1,944	1,772	14,383	10,581	1,161	304
1923	37,166	941	690	2,392	2,059	16,462	12,762	1,500	360
1924	35,931	944	675	2,338	2,054	16,239	11,930	1,368	383
1925	38,339	872	635	2,445	1,985	17,148	13,287	1,529	438
1926	36,936	834	575	2,047	2,001	15,571	14,189	1,326	393
1927	34,332	722	509	1,795	1,846	14,476	13,389	1,320	475
1928	34,142	766	445	1,803	1,677	13,978	13,630	1,365	478
1929	36,886	678	554	1,771	2,368	15,462	14,149	1,418	486

[1] Statistics reported by the Bureau of the Census and the Forest Service.

On the whole, the Lake, Middle Atlantic, and Central regions, with lesser contributions from New England which did not reach its peak in lumber cut until 10 years later, continued to supply the major part of the Nation's lumber cut until about 1899, at which time their combined cut not only commenced to fall off in itself but even more rapidly in relation to the rapidly expanding cut in the South. By 1929 all three were below the 2½ billion mark. The South reached its peak of 20 billion board feet about 1909 at which time it was supplying nearly half the cut for the entire country. Since that time it has rather slowly fallen off but in 1929 it was still slightly in excess of the Pacific Coast cut, which assumed significant proportions soon after 1909 and has mounted rapidly since then. Considering the relatively large supply of virgin timber in the Pacific Coast as compared with that of the South and the depleted condition of the growing stock as a whole in the South, it seems not only very probable, but also desirable, viewed from the aspect of rehabilitating and organizing on a sustained yield basis the latter's forest capital, that the cut of lumber in the Pacific Coast region should assume and hold the regionally predominant position for a limited period of time. Our domestic supply of hardwoods, however, must continue to come from the forests of the East and South, for western forests are practically all softwoods.

FUEL WOOD

The average yearly production of forest fuel wood in the period 1925–29 is shown to be 61 million cords (table 13), of which about 42 million cords are charged as drain on the commercial forests. The drain on cordwood stands is estimated to be 28 million cords, and that on saw-timber stands the equivalent of 14 million cords.

Quantitatively, fuel wood, comprising 13 percent of the saw timber cut and 28 percent of the total cut, is second in importance among forest commodities. However, since it is the least exacting so far as technical specifications or qualities are concerned, it is, of all the major commodities, the one that can best be furnished by improvement cuttings in both cordwood and saw-timber stands, or by the salvaging of waste in logging. In most European countries fuel wood is supplied in these ways and so made a means of improving the forest. In the United States the bulk of the fuel wood drain is still either from saw-timber trees or smaller trees which theoretically should be left to produce saw timber.

Fuel wood is a relatively bulky, low-value commodity, and therefore not adapted to bear the cost of long transportation. Thus it is at a disadvantage in competition with other fuels, especially in the urban communities. Quantitatively, the regional fuel wood cut corresponds more closely with regional population than that of any other major timber commodity.

On the whole, statistics on fuel wood cut (and consumption) are hardly satisfactory, and there may be a considerable percentage of error in those presented. Those available, together with common knowledge of the increasing use of other fuels, particularly in the urban centers, indicate a sizable falling off in the fuel wood cut in recent years.

HEWED TIES

In amount of timber drain, hewed ties rank third, although falling far short of either lumber or fuel. This cut, amounting to over 2 billion board feet annually, is considered as coming entirely from saw timber. Both hardwoods and softwoods are used. The great bulk of the hewed-tie cut comes from the South; more, in fact, than from all the rest of the country.

FENCE POSTS

The amount of timber cut annually for round and split fence posts approximates that for hewed ties, but unlike that for ties, the drain falls only in part on saw timber. The South furnishes the great bulk of the fence-post cut.

PULPWOOD

The pulpwood cut approximates quantitatively that for hewed ties and for fence posts. It comes both from saw timber and cordwood—the greater bulk from the former. Regionally the Lake States and New England each supply 28 percent, the South 17 percent, the Pacific Coast 12, the Middle Atlantic 11, and the Central 4 percent. The pulping properties required in pulpwood are such that a limited number of species, such as spruce, fir, hemlock, aspen, etc., have come to be known as standard pulpwood species. The particular properties of such species are further associated with individual processes of pulp manufacture. Pulpwood supplies must be in geographic or economic proximity to pulp and paper plants that involve large investments and are not easily moved, or else the domestic supplies lose out in competition with foreign (especially Canadian) supplies.

Theoretically there are vast quantities of pulpwood available in this country. Actually drain has proceeded so nearly to the point of exhaustion of the economically accessible and suitable local supplies, when compared with the cost of foreign supplies, that more than half of the pulpwood, wood pulp, and paper supplies of the country are at present obtained from other countries. The pulpwood drain and its relation to the forest supplies of the United States, in short, constitutes a highly complicated and important subject, aspects of which are treated elsewhere in this section and in the section on Our National Timber Requirements.

TIMBER LOSSES

Forest losses resulting from forest fires, insects, disease, naval-stores operations, drought, and wind amount to about 1,800 million cubic feet per year, or about 4¾ billion board feet in saw-timber trees and about 11 million cords in cordwood trees. (Table 10.) Much of this loss is caused by fires that might have been prevented or checked, and by epidemics of insects and disease, the ravages of which in many instances could have been greatly modified under a more effective system of forest management.

FIRE LOSSES

Timber killed annually by fire and not utilized during the years 1925 to 1929, inclusive, is estimated at over 870 million cubic feet, about a third of which is in saw-timber trees. (Table 15.) Fire losses in trees of saw-timber size amount to nearly 1,400 million board feet, and in trees of cordwood size to nearly 7 million cords.

TABLE 15.—*Timber killed each year by fire and not utilized (fire loss) in the commercial forests of the United States, by character of growth and region* [1]

Region	All timber			Saw-timber trees			Cordwood trees		
	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood
	M cu ft.	*M cu. ft.*	*M cu. ft.*	*M ft. b.m.*	*M ft. b.m.*	*M ft. b.m.*	*Cords*	*Cords*	*Cords*
New England	14,515	4,041	10,474	2,370	834	1,536	149,963	40,621	109,342
Middle Atlantic	52,111	13,463	38,648	7,171	1,822	5,349	561,327	144,622	416,705
Lake	63,011	20,201	42,810	3,740	895	2,845	782,734	221,224	561,510
Central	87,153	8,007	79,146	12,050	985	11,065	937,777	85,873	851,904
South	294,756	196,634	98,122	395,314	276,824	118,490	2,373,504	1,641,241	732,263
Pacific Coast	182,022	182,022	-------	563,549	563,549	-------	902,822	902,822	-------
North Rocky Mountain	172,829	172,829	-------	392,944	392,944	-------	1,177,243	1,177,243	-------
South Rocky Mountain	4,293	4,293	-------	13,095	13,095	-------	18,348	18,348	-------
Total	870,690	601,490	269,200	1,390,233	1,250,948	139,285	6,903,718	4,231,994	2,671,724

[1] Based upon the quantity of timber killed and not utilized, 1925 to 1929, inclusive.

These losses do not include the damage done to the trees that survive. Nor do they include the destruction of young growing stock below cordwood size, which is a far more formidable loss and one which is largely responsible for the very unsatisfactory regrowth conditions, especially in the poor and nonrestocking areas. Fire, which accompanies destructive methods of logging, has, through repeated burning of young trees and complete destruction of saplings and seedlings, been responsible primarily for the deterioration or devastation of immense

areas of forest land, and has been an outstanding factor in keeping the forest growth of the United States below the current drain upon our timber.

Fire and timber cutting, of course, not infrequently work together with their separate effect difficult to determine. Either one can cause forest deterioration or devastation. The difference between the two conditions is one of degree rather than kind. The bulk of the damage, however, is the result of fire after cutting. Only rarely does logging, no matter how carried on, alone result in devastation, but the resulting accumulation of highly inflammable slash invites fires. A single fire in such debris may and frequently does destroy all young growth and trees of seed-bearing size, leaving the area incapable of restocking by natural means. This phase of the forest problem is discussed under Progress in Forestry and Existing Plans in the section "Current Forest Devastation and Deterioration."

It is noteworthy that of the more than 40 million acres burned annually (1926-30 period) 90 percent was in the South, and that half of this was in two States. Although the area of unprotected land included in these figures represents an exceedingly rough estimate, it is certain that the great bulk of fire damage in terms of area burned over occurred on lands which had not been placed under organized fire protection. According to data available for 1930, 90 percent of the total area burned in that year was land not so protected. In the entire protected area the acreage burned was 1.4 percent of the total whereas the corresponding figure for the unprotected area was about 20 percent. These figures alone show that forest fire can be controlled, and they indicate the importance of extending organized fire protection to the still unprotected land.

INSECTS, DISEASE, WIND, AND DROUGHT

Timber killed annually by disease, insects, wind, naval-stores operations, and drought, and not utilized, during the years 1920 to 1929, inclusive, amounted to over 985 million cubic feet, including 592 million in saw-timber trees and 393 million in cordwood trees. (Table 16.) Losses in trees of saw-timber size amounted to nearly 3½ billion board feet, and in smaller trees to over 4 million cords.

TABLE 16.—*Timber killed each year by disease, insects, drought, wind, etc., and not utilized in the commercial forests of the United States, by character of growth and region* [1]

Region	All timber			Saw timber trees			Cordwood trees		
	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood	Total	Soft-wood	Hard-wood
	M. cu. ft.	*M. cu. ft.*	*M. cu. ft.*	*M. ft. b.m.*	*M. ft. b.m.*	*M. ft. b.m.*	*Cords*	*Cords*	*Cords*
New England	72,348	65,113	7,235	254,600	229,140	25,460	247,820	223,032	24,788
Middle Atlantic	11,374	-------	11,374	14,155	---------	14,155	91,244	---------	91,244
Lake	13,524	3,530	9,994	35,263	6,849	28,414	54,634	12,414	42,220
Central	109,088	2,916	106,172	59,248	1,452	57,796	1,072,164	28,713	1,043,451
South	298,899	145,576	153,323	711,126	510,073	201,053	1,899,083	761,850	1,137,233
Pacific Coast	324,599	324,599	-------	1,748,664	1,748,664	-------	371,711	371,711	---------
North Rocky Mountain	106,309	106,309	-------	474,550	474,550	-------	94,910	94,910	---------
South Rocky Mountain	49,068	49,068	-------	104,556	104,556	-------	249,796	249,796	---------
Total	985,209	697,111	288,098	3,402,162	3,075,284	326,878	4,081,362	1,742,426	2,338,936

[1] Based upon the volume of timber killed and not utilized, 1920 to 1929, inclusive. This estimate does not include normal losses that are constantly occurring in the forest but only large-scale or cataclysmic destruction. Data compiled in cooperation with the Bureau of Entomology, and the Division of Forest Pathology, Bureau of Plant Industry, U.S. Department of Agriculture.

Against the various causes of these losses science is waging relentless warfare. Forest entomologists have made notable progress in devising methods for checking forest insect depredations, and in working out control measures. Similarly, forest pathologists have made notable progress against the inroads of disease. These two phases of the forest problem, as well as that of forest-fire prevention and control, are discussed in sections, "Progress in Forest Pathology" and "Progress in Forest Entomology", under "Progress in Forestry and Existing Plans"; also in sections, "Protection Against Fire", "Protection Against Forest Insects", and "How to Stop Forest Devastation", under "National Programs Required and the Responsibility for Them."

TIMBER GROWTH

Growth is the characteristic which renders a forest, unlike a mine, susceptible to use and replacement on a permanently productive basis. Continued removal of timber without regard to or in excess of replacement by growth must sooner or later bring about the deterioration of the forest far below its producing capacity, if not its complete destruction. Such treatment of forests has been aptly described as timber mining. In an analysis of forest resources, therefore, a fundamental consideration is that of present and potential growth and of the relation between growth, drain through cutting and through losses by fire and other causes, and timber requirements. (See preceding subsection, "Forest Drain", and following section, "Our National Timber Requirements").

CURRENT ANNUAL GROWTH

The best available data on growth—though employed, as in the present discussion, with due consideration of age classes, density of stocking, mixture of species, site differences, and other factors that affect the rate of growth—afford a basis only for rough estimates of growth rates for the various forest types. Nevertheless, it is believed that the estimates and relationships presented and the inferences drawn therefrom are in the main dependable.

Table 17 gives the estimated present current annual growth in the United States as a whole of material large enough for saw timber, as well as that of all timber of usable size including both saw timber and cordwood. The estimates are for net growth, after allowing for so-called "normal" losses from decay, insects, etc. Abnormal or unusual losses from disease or insect epidemics, fires, hurricanes, etc., are taken care of in the estimates of drain. The growth in board feet consists of the growth on the present saw-timber stands, after deducting the growth on the saw-timber cut during the year and adding the total saw-timber volume on that portion of the cordwood area which passes into the saw-timber class each year. In the same way, the total growth on cordwood and saw-timber areas combined, expressed in cubic feet, consists of the net growth on stands remaining after the year's cut, plus the total volume on the restocking areas which pass into the cordwood class annually.

TABLE 17.—*Present current annual growth of usable material on commercial forest areas of the United States, by regions* [1]

Region	Combined saw-timber and cordwood growth			Saw-timber growth		
	Total	Softwood	Hardwood	Total	Softwood	Hardwood
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million feet board measure*	*Million feet board measure*	*Million feet board measure*
New England	427	162	265	764	410	354
Middle Atlantic	634	114	520	575	172	403
Lake	644	167	477	116	12	104
Central	1,128	83	1,045	727	41	686
South	4,784	2,994	1,790	6,799	4,946	1,853
Pacific Coast	680	675	5	1,785	1,765	20
North Rocky Mountain	416	416	----	576	576	----
South Rocky Mountain	199	199	----	389	389	----
Total	8,912	4,810	4,102	11,731	8,311	3,420

[1] Exclusive of Alaska. Growth figures represent volume of wood without bark, as in estimates of timber stand and drain. Board-foot volumes are on the basis of estimated lumber tally, assuming utilization consistent with good practice in each region. The growth in cubic feet is for stem wood, including all trees 4 inches or more in diameter breast height; it includes the limbs in the hardwoods.

Of nearly 12 billion board feet of saw-timber growth, over 70 percent is softwood. Of the total growth of almost 9 billion cubic feet, softwood comprises over 50 percent. More than one half of the saw-timber growth and also of the total growth is in the South, which has more than half of its forest area, or about 100 million acres, in growing saw timber and cordwood. The growth in the Lake region, especially for softwood, is strikingly low, owing primarily to the depletion of the stock of saw timber and cordwood; only one fifth of the 56 million acres of forest land bears growing saw timber or cordwood, and the remainder is classed either as restocking with trees below cordwood size, or as nonrestocking.

The comparatively low figures for growth in the West—about one seventh of the country's total for all growth, and less than one fourth for saw timber—are explained by the fact that much of the forest land in the West is covered with overmature timber which is making little or no net growth, and a large portion of the remainder is either deforested or covered with small reproduction. Moreover, the growth rates are generally low in the Rocky Mountain regions.

THE RELATION OF CURRENT GROWTH TO DRAIN

A simple comparison of current growth and drain means very little except as the quantity of surplus old growth, the extent, location, and condition of growing stock, and other pertinent factors are taken into consideration. The national ratios of 5 to 1 for drain and growth of material of saw-timber size, and of nearly 2 to 1 for material of saw-timber and cordwood size combined, are the net results of widely differing conditions which operate broadly to divide the whole country into three major growth sections. Table 18 shows regional growth and drain estimates combined by the regional groups within each of which the conditions in general are fairly similar. (See also figures 20 and 21.) It also shows, for comparison with drain, as a matter of importance, the saw-timber cut for lumber.

TABLE 18.—*Current annual growth and drain (1925–29 basis)*

Region	Combined saw timber and cordwood			Saw timber			
	Growth	Drain	Ratio, drain to growth	Growth	Drain	Ratio, drain to growth	Saw timber cut for lumber
	Million cubic feet	*Million cubic feet*		*Million feet board measure*	*Million feet board measure*		*Million feet board measure*
New England	427	706	1.7	764	1,905	2.5	783
Middle Atlantic	634	835	1.3	575	1,083	1.9	537
Total	1,061	1,541	1.5	1,339	2,988	2.2	1,320
Lake	644	1,343	2.1	116	2,748	23.7	1,997
Central	1,128	2,263	2.0	727	5,525	7.6	2,452
South	4,784	7,012	1.5	6,799	26,339	3.9	16,672
Total	6,556	10,618	1.6	7,642	34,612	4.5	21,121
Pacific Coast	680	3,444	5.1	1,785	18,799	10.5	13,693
North Rocky Mountain	416	566	1.4	576	2,378	4.1	1,405
South Rocky Mountain	199	182	0.9	389	657	1.7	461
Total	1,295	4,192	3.2	2,750	21,834	7.9	15,559
All regions	8,912	16,351	1.8	11,731	59,434	5.1	38,000

At one extreme are the western regions, particularly the Pacific Coast. In the West the drain is shown to be about eight times the growth for saw timber and more than three times the saw-timber and cordwood growth combined. This situation is largely explained, and also justified, by the existence of large quantities of overmature timber in the West which are making no net growth, but which may logically be drawn upon for some time to supply a considerable share of the Nation's needs for lumber. To just what extent and for what period this is true will depend in part upon the proportion of the old growth which may prove economically available. It will also be influenced by the extent to which cut-over areas are promptly and adequately restocked and protected. Lumber is the chief saw-timber product of the West which in large quantity can stand the cost of transportation to distant regions. It is natural, therefore, that lumber should account for a larger proportion of saw-timber drain in the West—over 70 percent—than in either of the other regional sections.

In the New England and Middle Atlantic regions is a very different situation. Here the old-growth stands with which excessive drain might be offset are New England hardwoods of poor quality and doubtful accessibility. Consequently, a saw-timber growth less than half the current saw-timber drain—even if it is slightly larger than the current cut for lumber—and an all-timber growth that is only two thirds of the total drain, represent a condition far less favorable locally than that indicated by the greater ratios in the West. Progressive depletion is still under way in both the New England and Middle Atlantic regions.

Most dangerous of all is the situation in the Lake-Central-South section, which comprises 310 million acres or 63 percent of our commercial forest land and a similarly large proportion of the country's timber producing potentialities. Here, it is true, high growth capacity per acre in most of this territory and relative proximity to large consuming centers, broadly speaking, constitute especially

favorable factors for the practice of forestry. But, on the other hand, because of the practical exhaustion of old-growth supplies and the large proportion of the area with growth below cordwood size or with none at all, the high ratios of drain to growth—4.5 to 1 for saw timber and 1.6 to 1 for all timber—signify a progressive impoverishment of a forest capital or growing stock already seriously depleted. Consequently, it would appear that the welfare of the forest resources—with saw timber the main object of management—can only be safeguarded by a drastic reduction in saw-timber drain in the Lake-Central-South section. Indeed, as will be shown later, a substantial reduction in the lumber cut below that for the 1925–29 period appears to be inevitable.

THE SIGNIFICANCE OF RECENT TRENDS TO FUTURE GROWTH

It is, of course, impossible to forecast all the factors that will influence future growth totals, even by 1950, and no attempt will be made to do so. The growth figures in table 19 are in no way intended as a forecast. The effect of certain assumptions as to fire protection and drain can, however, be roughly estimated. Better fire protection, and insect and disease control, would tend to hasten the restocking of cut-over areas, and to increase growth in all classes of stands. Twenty years, however, is too short a period for such improvements to have much effect upon annual growth of saw timber and cordwood. Moreover, it is wholly unlikely that abnormal losses from fire or other causes will be wholly eliminated.

TABLE 19.—*Estimated possible current annual growth and average annual drain as of 1950 compared to those on present commercial forest areas* [1]

Region	1925–29 rate of drain		Assumed average annual drain 1930–50		Growth on combined saw timber and cordwood		Growth on saw timber	
	Total	Saw timber	Total	Saw timber	1930	1950	1930	1950
	Million cu. ft.	*Million ft. b.m.*	*Million cu. ft.*	*Million ft. b.m.*	*Million cu. ft.*	*Million cu. ft.*	*Million ft. b.m.*	*Million ft. b.m.*
New England	706	1,905	350	950	427	470	764	890
Middle Atlantic	835	1,083	420	540	634	760	575	1,050
Total	1,541	2,988	770	1,490	1,061	1,230	1,339	1,940
Lake	1,343	2,748	670	1,400	644	740	116	270
Central	2,263	5,525	1,120	2,800	1,128	1,170	727	410
South	7,012	26,339	3,500	13,170	4,784	6,460	6,799	7,430
Total	10,618	34,612	5,290	17,370	6,556	8,370	7,642	8,110
Pacific Coast	3,444	18,799	3,440	18,800	680	530	1,785	1,850
North Rocky Mountain	566	2,378	570	2,400	416	420	576	480
South Rocky Mountain	182	657	180	700	199	200	389	440
Total	4,192	21,834	4,190	21,900	1,295	1,150	2,750	2,770
All regions	16,351	59,434	10,250	40,760	8,912	10,750	11,731	12,820

[1] Based on arbitrary assumptions as to drain.

Cutting in the East at whatever rate in excess of annual growth would tend to restrict future growth by depleting the growing stock capable of producing merchantable material. Severe drain upon the cordwood stands would limit the acreage advancing from cordwood

to saw timber and therefore reduce the saw-timber growth. The degree to which cutting is made in accordance with good silvicultural practices also has a distinct bearing upon growth. Such practices would tend to increase total yields and at the same time build up the growing stock in the cordwood and younger age classes.

The factor of greatest weight and uncertainty is that of drain—its value, character, location, etc. Although the estimated current annual growth for 1950 given in table 19 is in no sense a prediction of what will actually transpire, an effort has been made to select assumptions as to drain which might conceivably be realized, taking into account the effect of the present depression, the bearing of limited usable supplies in the eastern forest regions, and the possibilities for constructive forestry measures. For all the eastern regions the drain for the period from 1930 to 1950 was assumed at an average rate equal to one half the 1925–29 drain. Because of the severe depletion of growing stock which has already taken place in these regions a continuation of the 1925–29 drain seems impossible. The current low ebb of lumber production, which is probably less than half the 1925–29 rate, probably will be followed by a period of increased production before the exhaustion of suitable saw-timber supplies forces a protracted restriction in the cut, especially in the Lake-Central-South section. Some students of the situation believe that by 1950 the saw-timber drain in the East is likely to be less than half the 1925–29 rate, but an average of one half for the two decades appears to be a reasonable assumption as a basis for this calculation. On the other hand, because of the large reservoir of old-growth stumpage, there seems to be no reason, with favorable economic conditions, why the 1925–29 rate of drain in the West as a whole may not be continued until 1950.

With these assumptions as to drain, forest conditions which might obtain in 1950 were projected. The stands in each region, as of 1930, were reduced at the assumed average rates of drain for the 20-year period. Growth was allowed on all stands until the theoretical time of cutting. An estimate based on the growth rate and age classes was then made of the area and volume of cordwood stands which would reach saw-timber size by 1950, the theoretical amount which might so mature being reduced by the area which would be cut over as cordwood. In a similar manner, the amount of restocking land which would advance to cordwood size was estimated. With the distribution of growth classes and the corresponding volumes of standing timber in 1950 set up in this way, the theoretical current annual growth at that time was calculated by the same method used for present current growth.

Of special importance is the comparison, shown in table 19, of current growth as of 1950 with current 1930 growth both for saw timber, and for saw timber and cordwood combined, and also with the assumed reduced drains. For the New England and Middle Atlantic regions together the 1950 growth rates of both saw timber, and saw timber and cordwood combined, would increase, and would exceed the assumed average drains. In the Lake-Central-South section, on the other hand, the growth of saw timber alone would remain about as at present and also at less than one half of the assumed average drain. The combined saw timber and cordwood growth, however, would exceed the present growth and also the as-

sumed average drain. The disparity between growth and drain for saw timber in the Lake and Central regions is particularly striking. These estimates indicate that, from the standpoint of saw-timber production, even an average drain of only 50 percent of the 1925–29 rate would still further reduce an already severely depleted growing stock in the Lake, Central, and South regions. In the western group the rates of growth in comparison with drain would remain much the same as for 1925–29.

Of equal importance from the standpoint of the forest situation in 1950 is a consideration of the areas of age classes and of the stands

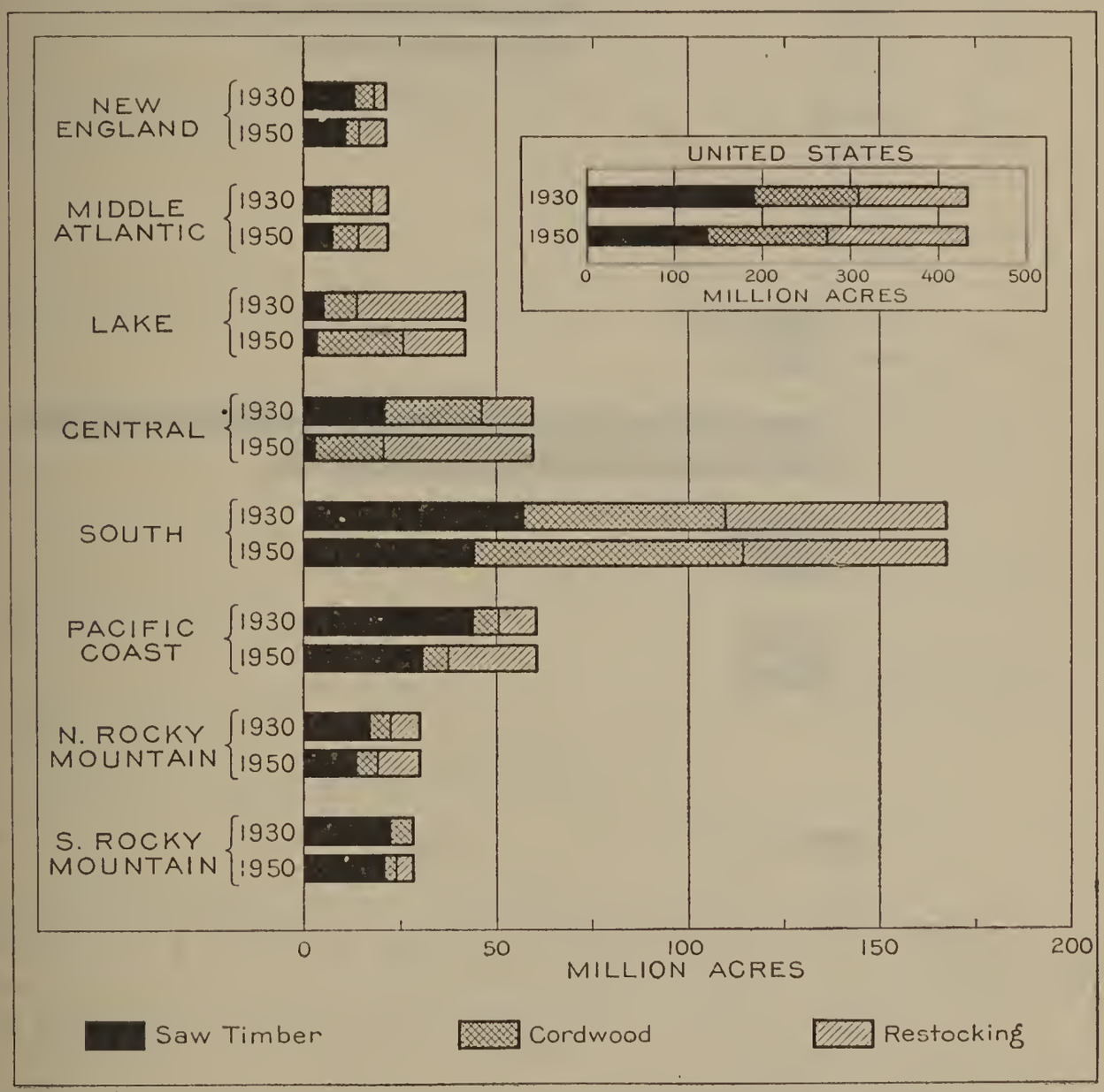

FIGURE 17.—Present distribution of forest areas and their estimated distribution in 1950, by regions. The 1950 estimate is based on the 1925–29 average drain in the West, and in the East on half the 1925–29 drain. Present devastated areas, estimated at 63 million acres, not included.

of timber, in comparison with the present. The possible distribution of age-class areas in 1950 in comparison with 1930 is shown in figure 17, excluding 63 million acres that probably will not produce commercially valuable saw-timber stands within the period required for existing growth, if any, to mature. Assuming reasonably efficient fire protection, the areas of restocking land might increase nationally from the present 123 million to perhaps 160 million acres. In arriving at this figure prompt restocking of lands cut over was assumed. The cordwood area might increase from 121 to something like 135 million acres, with a more or less proportionate increase in volume. Of greater interest and concern, however, are the estimated

trends as to areas and volumes of saw timber. Table 20 shows in a summarized way these two features. Figure 18 compares possible 1950 volumes with the present. Under the assumptions made, reductions both in saw-timber areas and in saw-timber volume would probably be marked. These apparent reductions in saw-timber

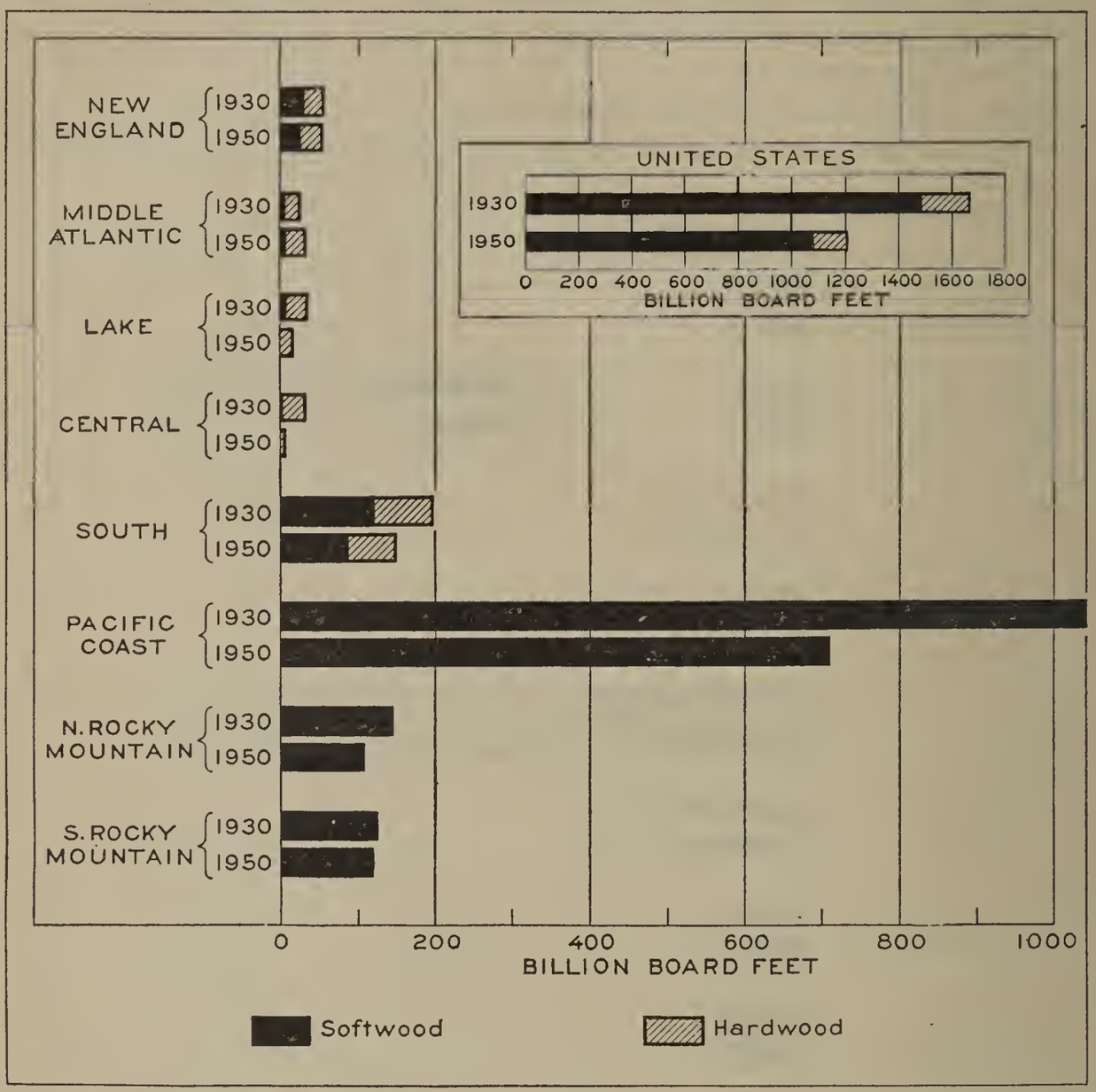

FIGURE 18.—Present volume of hardwood and softwood saw timber and the estimated volume in 1950, by regions. The 1950 estimate is based on the 1925–29 average drain in the West, and in the East on half the 1925–29 drain.

area could be minimized by a general adoption of silviculturally desirable selective cutting.

The reduction in saw-timber areas would be most noticeable in the Lake, Central, and Pacific Coast regions. The reduction in saw-timber volume would be very largely in the Pacific Coast region. Actual depletion, however, would be most severe in the Lake and Central regions where the supplies of softwood saw timber would be practically exhausted. This means that in these two regions paucity of supply would force a still greater reduction in saw-timber drain than that assumed in this calculation.

TABLE 20.—*Estimated possible areas and volumes of saw timber in 1950 on basis of 1925–29 drain continuing in the West and one half 1925–29 drain in the East*

Region	Annual saw-timber drain		Saw-timber area		Saw-timber volume	
	1925–29 rate	Assumed rate 1930–50	1930	1950	1930	1950
	Billion ft. b.m.	*Billion ft. b.m.*	*Thousand acres*	*Thousand acres*	*Billion ft. b.m.*	*Billion ft. b.m.*
New England	1.90	0.95	13,860	10,990	57.87	57.37
Middle Atlantic	1.08	0.54	7,294	7,921	26.15	34.81
Lake	2.75	1.40	5,095	3,669	35.88	18.59
Central	5.52	2.80	21,224	2,996	34.62	5.72
South	26.34	13.17	57,265	44,065	199.30	150.19
Pacific Coast	18.80	18.80	44,140	30,954	1,041.63	710.78
North Rocky Mountain	2.38	2.40	17,026	13,808	146.39	109.12
South Rocky Mountain	.66	.70	22,741	21,463	125.96	120.66
Total	59.43	40.76	188,645	135,866	1,667.80	1,207.24

What the effect would be of continuing the 1925–29 rate of saw-timber drain in the West depends upon a number of factors. Chief among these is the extent to which the remaining stands of old growth will prove to be economically available. It also depends upon the extent to which cutting is made in accordance with the dictates of good silvicultural and forest regulation principles. For example, greater recourse to partial or selective cutting would be advantageous. Although something far short of the ideal will be obtained in allocation and method of cutting, it seems reasonable, in the light of increasing economic availability, that the 1925–29 drain should continue until at least 1950. The indications are, however, that a marked increase in this rate of drain or even indefinite prolongation of it would reduce the growing stock below the amount required for permanent continuation of such production.

In brief, it appears that a continuation of the 1925–29 drain is feasible in the West but that it would be disastrous to the welfare of the forests and the forest industries in the East, unless the best data now available prove later to have been greatly in error. A 50 percent reduction in the average drain to 1950 theoretically might stabilize the situation on that level in the New England and Middle Atlantic regions. In the other eastern regions a greater proportionate reduction may be necessary to prevent further impoverishment of the already depleted growing stocks. Additional measures will probably be needed to rehabilitate these growing stocks.

To look beyond 1950 in the matter of areas of age classes and volumes of standing timber amounts to little more than a guess. However, the effort to do so may help to correct some misunderstandings. It is sometimes stated that the increasing shortage of saw-timber stands in the East will be offset in a few decades without any particular human effort by a huge wave of second growth reaching saw-timber size. Such a wave appears to be in prospect in the Lake States after 1950, but it is doubtful if the saw-timber growth will rise much above 1 billion board feet per year. A similar increase in available saw timber may come to pass in the Central region at a still later date but in the meantime saw-timber production in this region may drop to a very low ebb.

Without drastic reduction of drain and the most careful husbanding of sapling, cordwood, and young saw-timber stands, there does not seem to be any prospect of an enlarged volume of available saw timber in the New England and Middle Atlantic regions. At present rapid depletion of cordwood stands is preventing the building up of growing stock of saw-timber size in these two regions. Even with drain at only half the 1925–29 rate the area in the restocking and deforested classes seems likely to increase to nearly half the total forest area of these regions by 1950.

Finally, these calculations afford no evidence that the volume of young growth annually approaching maturity in the South after 1950 will be any greater than the amount maturing annually prior to that time. The figures indicate that the forest situation in this great region may remain without material change for some decades unless forestry measures are aggressively adopted throughout the region.

SUSTAINED YIELD POSSIBILITIES

An underlying purpose in the management of forests is to provide a stable and ample supply of usable timber of the character and quality needed to meet the requirements of the users of wood and wood products. This may apply to a single forest property, to the forests of a region as a whole, or to an entire country. Forests so organized and managed are referred to as being on a sustained-yield basis, and the volume of material present, as the basis for management is known as the growing stock. Under such management the age classes will be more or less evenly distributed.

Where there is a large surplus of mature and overmature timber, as in the Pacific Coast region, the rate of cutting can exceed the growth until the surplus is used up without violating the principle of sustained yield. The cutting of this surplus should, of course, be extended over a sufficient number of years to permit the existing young stands to mature and the cut-over land to restock in a sequence which will permit cutting to continue without interruption. Where there is a serious deficiency in mature timber and timber approaching maturity, as in the East, continued cutting of saw timber in excess of the annual growth must sooner or later exhaust the supply of saw timber that is large enough for economic utilization.

Except for special situations like that on the Pacific coast, a fairly even distribution of age classes is necessary before a volume approximately equal to the annual growth can be permanently cut each year. It is evident, therefore, that there is a close relationship between the volume of growing stock and the volume of usable material that can be cut annually. If we may assume that a forest should be handled on an 80-year rotation for the production of saw timber we may think of such a forest under sustained-yield management as being in the form of eight 10-year groups or age classes, the oldest group affording the usable material for the first 10 years. The next group would reach the age for cutting during the second 10-year period and so on, until at the end of the 80-year rotation the area first cut over would again be ready for cutting. Such a forest contains the minimum growing stock that can supply a continuous cut equivalent to the annual growth on the whole area without, as a rule, necessitating the cutting of timber below the rotation age.

It will be instructive to consider some of the growing-stock aspects of the forests in the several regions in relation to sustained saw-timber yield. The results of theoretical calculations of the yields which might be maintained on three assumptions of regulated growing stock are presented in table 21. The first column is based on a growing stock in which the saw-timber volume equals the volume of present saw-timber stands; the second column upon a growing stock in which the saw-timber volume equals that portion of present saw-timber stands estimated to have a positive utilization value under 1925–29 conditions (see preceding subsection, "Availability of Timber Stands"); the third upon a growing stock in which the saw-timber volume equals the estimated saw-timber volumes in 1950 on the basis set up in table 20.

TABLE 21.—*Estimated saw-timber yields theoretically possible on forests with regular distribution of age classes based on assumed saw-timber volumes*

Region	Basis			Average annual saw-timber drain 1925–29
	Yield based on total 1930 saw-timber volume	Yield based on 1930 saw-timber volumes having positive utilization value	Yield based on estimated 1950 saw-timber volume	
	Million feet b.m.	*Million feet b.m.*	*Million feet b.m.*	*Million feet b.m.*
New England	2,094	1,696	2,121	1,905
Middle Atlantic	991	702	1,333	1,083
Total	3,085	2,398	3,454	2,988
Lake	1,374	1,123	744	2,748
Central	1,366	1,133	229	5,525
South	9,186	7,535	6,901	26,339
Total	11,926	9,791	7,874	34,612
Pacific Coast	26,041	12,674	17,770	18,799
North Rocky Mountain	2,928	867	2,182	2,378
South Rocky Mountain	2,519	829	2,413	657
Total	31,488	14,370	22,365	21,834
All regions	46,499	26,559	33,693	59,434

These calculations are premised on an even distribution of age classes, no cutting except for salvage, thinnings and other improvement cuttings, until the saw timber reaches rotation age; and measures adequate to restock cut-over lands and to protect the growing stock. Rotations also are necessarily assumed—60 years for softwoods in the South, 80 years for hardwoods in the South and for all other species in the other eastern regions, 100 years in the Pacific Coast region, and 120 years in the Rocky Mountain regions. For convenient reference table 21 also gives the 1925–29 average saw-timber drain.

These calculations indicate (column 1, table 21) in New England and the Middle Atlantic regions that regulated growing stock with saw-timber volumes equal to present volumes would just about support through sustained yield, a drain of saw timber equal to the 1925–29 rate. This indicated sustained yield exceeds the present annual growth because it assumes no cutting of stands below rotation age other than in cultural operations, whereas under current practices there is a heavy drain in both cordwood and small saw-timber

stands, which keeps actual growth of saw timber at a low figure. Even on the basis of the smaller regulated growing stock assumed in the second column a sustained yield of more than two thirds of the 1925–29 saw-timber drain could be maintained.

Regulated growing stock with saw-timber volumes equal to the present volumes (column 1) in that great Lake-Central-South belt would be adequate to maintain about one third of the 1925–29 saw-timber drain. This disparity would be further increased with the smaller growing stocks under the other two assumptions.

The sustained-yield possibilities indicated for the western regions have little significance because of the abnormally large volumes of over-mature timber now present. It is obvious that the true sustained-yield possibility of the western regions is less than that indicated in the first column and perhaps even less than that indicated by the calculated 1950 growing stocks (column 3). Although it is believed that a great many years will elapse before all of the more remote and otherwise less desirable stands become economically available, it is probable that as time passes, the margin of accessibility will be extended.

These calculations, as previously implied, are useful in giving a proper perspective to the existing growing stock situation from the standpoint of sustained yield. As a matter of fact, the situation is somewhat less favorable than might be implied from the figures alone. Individual properties or localities within regions are, as a rule, not characterized by the regular distribution of age classes needed for sustained yield in keeping with actual stand volumes. Such distribution of age classes may not exist even for the region as a whole. Moreover, heavy depletion is actually taking place quite generally in the cordwood and second-growth saw-timber stands below rotation age.

It remains to consider sustained yields which might be obtained under some combination of intensive forestry, extensive forestry, and simple protection against fire. It is believed that the play of economic forces will lead to the practice of intensive forestry on the most favorable situations before anything more than fire protection will be economically justifiable upon the poorer and more remote lands. At the same time, because of ownership or other factors, certain lands will be given little, if any, forestry treatment even though physically and economically suited to it. Some combination of extensive and intensive forestry, however, appears to be closer to the probable realities than would a premise which involved only extensive forestry or only intensive forestry. The relative acreages assumed for each type are in no sense forecasts of what will happen.

For this discussion simple protection means a degree of protection which will prevent fires from causing a serious drain at any time.

Extensive forestry embraces fire protection as just defined, and such cutting practices or simple silvicultural measures as are necessary to maintain production in sufficient quantity for commercial utilization. It would include, as occasion requires, such measures as deferring cutting until reproduction has become established, slash disposal as an aid in fire protection, the preservation of advance reproduction, the leaving of seed trees, prevention of overgrazing, and girdling cull hardwoods to permit valuable young growth to develop. It will not ordinarily include planting.

Intensive forestry is used to include a very high degree of protection against fire, insects, and disease. In addition, it will require cutting

practices and various cultural measures, including planting, to increase both the quantity and quality of the yield to a point consistent with the productive capacity of the land. All of the areas under intensive forestry, therefore, would be in a good growing condition and well stocked with desirable species.

An allocation of forest areas according to the intensity of management which might theoretically be attained at some time in the distant future is illustrated by table 22. The application of intensive and extensive forestry on anything like the scale indicated in this table can, of course, be brought about only after a long period, perhaps a tree generation, and then only as a result of the most aggressive and sustained efforts of all agencies concerned. This table takes cognizance not only of the present commercial forest areas, but also of the 54.7 million acres of farm land which are estimated to be available for forest use because not needed for agriculture. (See section, "Forest Land the Basic Resource.") The table classes as productive forest land not only the open or denuded areas which may be expected to restock naturally during a long period of years, but also the area which is set up for planting under the section "Reforestation of Barren and Unproductive Land." It excludes as not available for timber use those areas which other sections of this report estimate will need to be reserved for recreation or other purposes. Under the general application of forestry practices assumed in this calculation denudation would be largely eliminated. Whatever error may be involved because of denudation before this theoretical plan of land use could be attained is on the optimistic side. Therefore, recommendations for action based on the resulting growth calculation will be conservative.

The theoretical yield which might be obtained under the conditions set up in table 22 is shown in table 23. The calculations are shown only on a cubic-foot basis, but the bulk of the cut would, of course, be in trees of saw-timber size.

TABLE 22.—*Hypothetical allocation by types of management of areas prospectively available for timber use*

Region	Total[1]	Area for intensive forestry	Area for extensive forestry	Area for simple protection		
				Forested land		Not likely to restock[2]
				Relatively favorable	Relatively unfavorable	
	Million acres	*Million acres*	*Million acres*	*Million acres*	*Million acres*	*Million acres*
New England	23.1	5.0	12.0	1.8	0.7	3.6
Middle Atlantic	30.1	6.0	14.0	2.1		8.0
Total	53.2	11.0	26.0	3.9	.7	11.6
Lake States	60.7	11.0	30.2	5.0	5.0	9.5
Central	75.6	10.0	41.8	5.9	8.6	9.3
South	205.9	30.0	131.5	14.8	17.8	11.8
Total	342.2	51.0	203.5	25.7	31.4	30.6
Pacific Coast	57.4	7.0	33.0	4.8	8.8	3.8
North Rocky Mountain	26.8	.5	10.0	4.1	10.4	1.8
South Rocky Mountain	29.0	.5	6.4	2.2	18.4	1.5
Total	113.2	8.0	49.4	11.1	37.6	7.1
All regions	508.6	70.0	278.9	40.7	69.7	49.3

[1] Includes the 494.9 million acres of present commercial forest area and the 54.7 million acres of farm land now available for forestry, with reductions of 2 million acres of forest land to be cleared for agriculture in the West and of 39 million acres for recreation and other purposes.

[2] Residual area of denuded commercial forest land and agricultural land available for timber use, after allowing natural restocking of 42.8 million acres and planting of 25.5 million acres.

TABLE 23.—*Theoretical future growth under the hypothetical allocation of areas to types of management given in table 22*

Region	Total theoretical growth	Intensive forestry area	Extensive forestry area	On simple-protection areas	
				Relatively favorable for forestry	Relatively unfavorable for forestry
	Million cubic feet	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*	*Million cubic feet*
New England	747.9	307.0	398.4	35.5	7.0
Middle Atlantic	1,001.8	366.6	575.4	59.8	
Total	1,749.7	673.6	973.8	95.3	7.0
Lake	1,773.4	590.7	1,081.2	76.5	25.0
Central	1,959.1	483.0	1,295.8	111.5	68.8
South	9,500.0	2,193.0	6,759.1	423.3	124.6
Total	13,232.5	3,266.7	9,136.1	611.3	218.4
Pacific Coast	2,059.2	686.1	1,230.9	54.2	88.0
North Rocky Mountain	499.1	30.5	308.0	56.6	104.0
South Rocky Mountain	214.5	11.9	95.4	15.2	92.0
Total	2,772.8	728.5	1,634.3	126.0	284.0
All regions	17,755.0	4,668.8	11,744.2	832.6	509.4

The growth rates used in this calculation were derived from detailed consideration of present growth and future yield capacities for the principal timber types in each region. The areas relatively unfavorable for forestry as a rule are characterized by poor growing conditions. Nevertheless, in recognition of the fact that some may become a factor in timber supply, a nominal growth rate was applied. The present average growth of 21 cubic feet per acre for the 432 million acres of present commercial forest land now in productive condition was applied to those relatively favorable areas allocated to simple protection. In the areas allocated to extensive forestry the growth rate averages about 42 cubic feet per acre, while on the intensive forestry area the average rate for all regions is about 67 cubic feet.

The estimated future annual growth for the entire 508.6 million acres, on the basis of the assumed allocations to the several types of management is 17,755 million cubic feet. The distribution of this growth, in comparison to present growth, is shown in figure 19. The saw timber equivalent of this total growth is estimated to be about 60 billion board feet.

Among the requisites for attaining and maintaining such a yield is the establishment of forest growing stock adequate in character and amount. The minimum growing stocks which would be required to sustain a yield equal to the growth shown in table 23 on a saw-timber basis, with uniform rotations as assumed in table 21, is presented in table 24. As a matter of interest there is also included in table 24 the total volume of the existing stands.

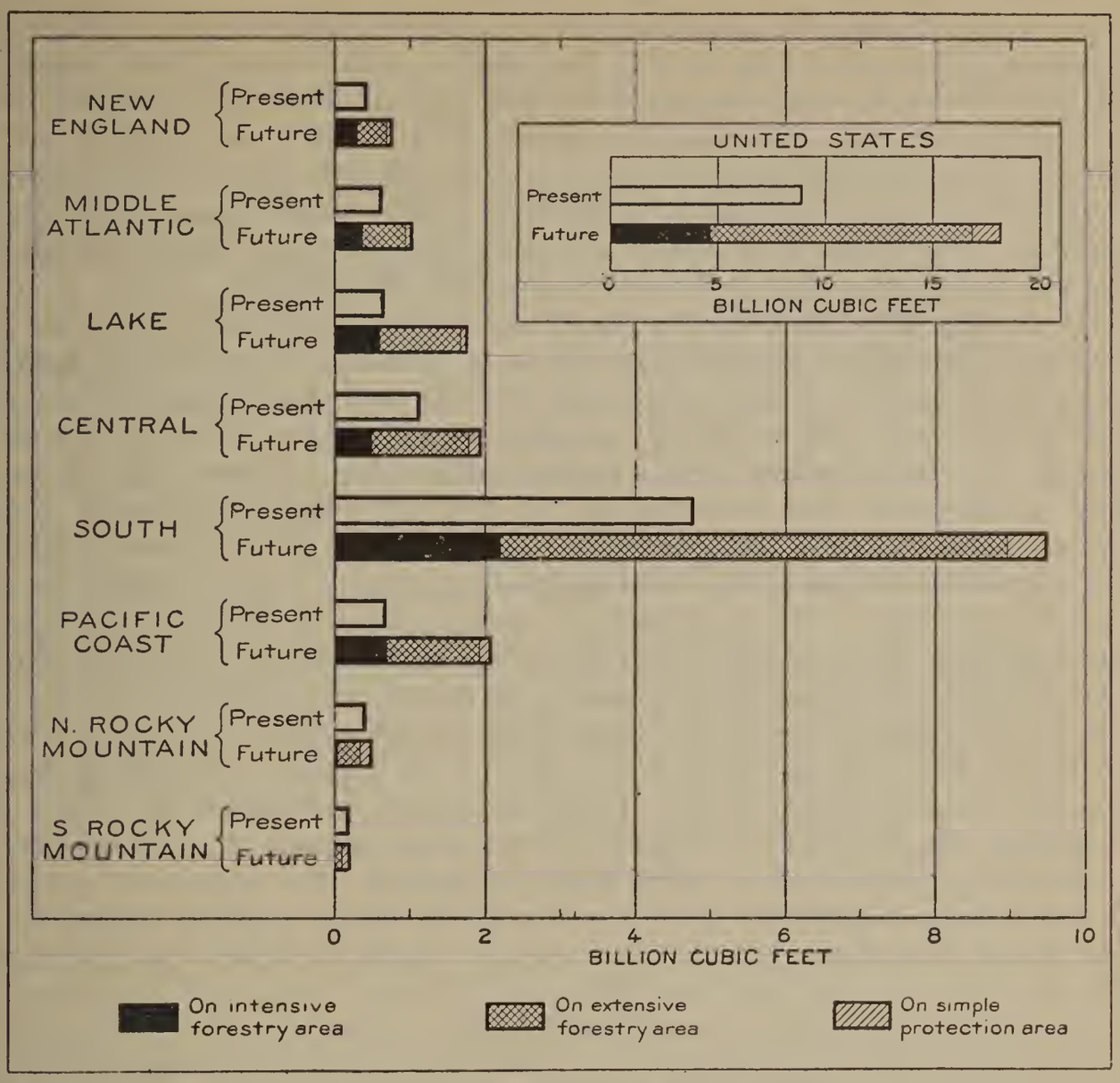

FIGURE 19.—Theoretical future annual growth compared to present growth. (Total growth of saw-timber and cordwood in cubic feet.)

TABLE 24.—*Minimum growing stocks required to maintain theoretical growth shown in table 23*

Region	Total theoretical growth	Growing stocks required	Present growing stocks	Ratio of present to required growing stocks
	Million cubic feet	*Billion cubic feet*	*Billion cubic feet*	
New England	747.9	28.0	25.2	0.9
Middle Atlantic	1,001.8	37.6	22.7	.6
Total	1,749.7	65.6	47.9	.7
Lake	1,773.4	66.6	21.6	.3
Central	1,959.1	73.5	30.7	.4
South	9,500.0	288.0	113.8	.4
Total	13,232.5	428.1	166.1	.4
Pacific Coast	2,059.2	98.8	191.7	1.9
North Rocky Mountain	499.1	29.1	47.8	1.6
South Rocky Mountain	214.5	12.5	33.3	2.7
Total	2,772.8	140.4	272.8	1.9
All regions	17,755.0	634.1	486.8	.8

It would appear that the present volume of timber in New England, if it should all prove to be economically available and were properly distributed as to age classes, would almost sustain the growth indicated in both tables 23 and 24. In the Middle Atlantic region, under the same assumptions, the present stands would have to be increased about 65 percent. In the combined Lake, Central, and Southern regions more than 2.5 times the present growing stock would be needed to achieve the indicated sustained production.

In reality the stands in the East, generally speaking, are not regularly distributed as to age classes. Few of them are in a satisfactory silvicultural condition, and it is doubtful whether all of them will ever become economically available. For these reasons the deficiencies in the growing stocks indicated for the eastern regions probably understate the seriousness of the situation. In short, after allowing for sizable inaccuracies in stand and growth estimates it seems conclusive that the existing growing stocks in the East are much less than adequate to maintain, on a saw-timber rotation, anything approaching the sustained yields set up in table 23. This would be true even if the growing stocks were properly regulated.

In the West, on the other hand, the present stands appear to exceed by more than 90 percent the volume of regulated growing stock necessary to maintain the sustained yield indicated in table 23. However, the factor of inaccessibility, even though it may prove of diminishing importance, will tend to reduce the apparent surplus. Nevertheless, regulated growing stocks in those regions equal to or somewhat less than the present stands would probably be adequate.

SUMMARY

The preceding pages have presented the outstanding aspects of the forest situation in the several regions, both from the standpoint of current growth, and from that of the theoretical sustained-yield possibilities in relation to the existing growing stocks. Without assuming that the calculations involved represent precise accuracy, or that they approximate the rates of drain and growth which will actually take place and which will be governed by circumstances which cannot accurately be foretold, it may yet be concluded that, irrespective of the existing economic depression, a considerable decline in the national cut is inevitable. This decline will be largely, if not entirely, in the eastern regions. The situation in the East is so serious that the severe reduction in the drain on the forest resulting from the economic depression during the past three years may be providential from the standpoint of the welfare of the forest resources.

The severity and duration of this decline in cut, and its ill effects nationally, regionally, and locally may be minimized in a number of ways. Further restricting abnormal losses by fire and other causes will serve to reduce the rate of depletion of the growing stock and facilitate the restocking of cut-over areas. The area of producing forest land can be increased by an aggressive program for planting the large area of open and nonproductive land now available for forestry.

Better utilization methods, more efficient marketing, and the accompanying reductions in waste would make it possible to cut a given quantity of usable products from a smaller volume of timber. Obtaining products other than lumber just as far as practical from improvement or salvage cuttings, using defective trees or portions of

the stand which now go to waste incident to saw-timber production would help build up the growing stock. The yield of usable growth could also be increased by careful selection of the stands to be cut and of the trees to be cut within those stands where partial cutting methods can be applied. Those stands and trees should be cut which offer no prospect of making a good rate of growth in volume or value, and those should be left which promise to increase rapidly in volume or value in the comparatively near future. Wherever silvicultural and economic conditions permit, a good stand of thrifty young and middle-aged trees should be left on cut-over lands. Through various silvicultural operations it would be possible to increase the proportion of fast growing or otherwise desirable species and more nearly to maintain that density of stand which is most favorable to rapid growth of usable timber.

While the application of these measures involves many silvicultural and economic factors concerning which much remains to be known, present knowledge is adequate for progressive improvements. Further knowledge can be gained only through a long-time program of research in silviculture, forest products utilization, forest economics, and related fields such as entomology, pathology, and plant and animal ecology.

THE BALANCE BETWEEN TIMBER SUPPLIES AND REQUIREMENTS

Several important factors, some of which are discussed in detail elsewhere in this report, should be briefly reviewed as a basis for an understanding of the relation of our timber supplies to our requirements, and for considering the need or justification for a program of forestry measures to increase supplies.

SHOULD SAW TIMBER BE THE MAJOR OBJECT OF A NATIONAL PROGRAM OF FORESTRY?

Lumber has always been, by all odds, our most important timber product. It accounts for more than half of the total cut. Most other important products may be obtained advantageously, wholly or partly, from trees of saw-timber size. Altogether more than three fourths of the products taken from the forest are obtained from saw timber.

Important though the growing number of chemical and synthetic wood products have been and will continue to be, it is not believed that the prospects for the development of new uses of wood justify the assumption that lumber and other mechanical products of saw timber will cease to constitute the major normal requirement.

Stumpage values for timber to be converted into lumber have in general been higher than for timber to be converted into other products. Furthermore, such other products as veneers and piling which return higher values to stumpage have, for the most part, been cut from trees of saw-timber size.

There are, of course, exceptions as in the case of pulpwood, but in most localities the management of forests for saw timber as the major object offers greater financial advantage than for smaller trees. Moreover, studies made in a number of widely different forest types summarized in table 4 of the section "Status and Opportunities of Private

Forestry" show conclusively that the financial return from the cutting of large saw-timber trees is greater than that from small saw-timber trees, because the products of the former are of higher value, and because the larger trees can be logged and milled much more cheaply than the smaller ones.

In the management of forests for saw timber there will always be a large volume of by-product material which may be converted into pulpwood, fuel wood, posts, or other so-called minor products. This material is available alike from cultural operations, from salvage of trees which may die or be killed by destructive agencies, or from waste incident to removal of saw logs. Not only, in most instances and in most localities, can minor products be thus obtained to the best financial advantage but such use facilitates these cultural and salvage operations which in themselves are a highly desirable feature of intensive and profitable forestry. These points also are further elaborated in the section on "Status and Opportunities of Private Forestry."

In short, it seems altogether probable that the best results in management, all things considered, will be achieved and that the normal requirements of the country for forest products best be met if regional and national programs of forestry are based upon saw timber as the major object of management and if sufficiently long rotations are used to produce saw timber of considerable size and relatively high quality.

PRESENT AND PROSPECTIVE NORMAL TIMBER REQUIREMENTS

The term "timber requirements" is used to denote the measure of use by consumers who are afforded a reasonable latitude in choice of readily available materials including timber and timber products. "Normal" requirements refers to the volume of such use that might logically be expected when general economic conditions are such that the Nation is conscious neither of depression nor of unusual prosperity.

The most tangible available criterion of requirements is consumption. However, since consumption of timber is likely to vary with the abundance, suitability, and cheapness of the supply, it affords only an approximate measure of requirements; it is likely to be less than requirements when ample suitable supplies are not readily available.

The impossibility of measuring accurately the net future effect of a complex of many influencing factors renders it impractical to make a precise forecast of future requirements. However, the section "Our National Timber Requirements", which follows, discusses in some detail the influence of various factors upon recent and prospective trends for the more important classes of timber commodities. That discussion indicates that 31 to 34 billion board feet is a fair measure of present normal requirements for lumber. It is not unlikely that research and improved manufacturing and marketing practices may, in the future, expand this normal requirement. On the other hand, in some regions and with respect to special commodities there is, for many years at least, the prospect of limited supplies. All things considered it appears reasonable to include a figure of 32 billion board feet of lumber in our estimate of normal timber requirements. This is appreciably below the consumption prior to the current economic depression.

The consumption of fuel wood, quantitatively the most important commodity next to lumber, has undoubtedly declined considerably during the past 20 years. However, it seems likely to continue as the chief fuel in rural sections. Present consumption may now approximate a minimum. It is estimated in the discussion of production (see table 13) that, of the total production of 61 million cords, 42 million cords, or over 4 billion cubic feet, should be considered as representing the actual drain for fuel wood. There is no clear justification for changing that figure for purposes of the present consideration.

Paper and other wood-pulp products appear to offer the prospect of a greater proportionate increase in timber requirements than does any other important class of timber products. At present our own forests supply only 44 percent of the pulpwood represented in our manufacture and consumption of paper and other wood-pulp products. The remainder is imported in the form of pulpwood, pulp, or paper. It is variously estimated that, translated into terms of pulpwood, the total requirements for wood-pulp products may by 1950 reach a figure between 22 and 30 million cords. For present purposes we may use a figure of 25 million cords. There is strong justification for becoming nationally self-sufficient in pulpwood supplies. The reasons are elaborated in the discussion on pulpwood, pulp, and paper in the section "Our National Timber Requirements". We may estimate that 25 million cords of pulpwood would mean about 2,758 million cubic feet, of which about 135 million cubic feet can possibly be considered as coming from Alaska. This would leave some 2,623 million cubic feet to be supplied by the forests of the United States proper.

Trends in minor and miscellaneous timber products tend to offset each other to such an extent that no other changes in the timber-use portion of the drain table for the period 1925–29 appear justifiable for purposes of the present discussion.

Although it is not considered likely that abnormal losses through fire and other causes will ever be eliminated, it seems logical to assume that a national program of forestry would justify reducing the loss from fire to one half and from other causes to three fourths of the 1925–29 estimates.

This basis of possible requirements and losses translated into terms of forest drain for use in considering the future situation as to normal timber requirements is briefly summarized as follows:

Type of drain	Saw timber (million board feet)	All timber (million cubic feet)
Lumber	32,000	6,207
Fuel wood	7,047	4,003
Pulpwood	4,363	2,623
Miscellaneous products	8,121	2,533
Fire losses	695	435
Other losses	2,552	739
	54,778	16,540

REGIONAL INTERDEPENDENCE FOR TIMBER SUPPLIES

The extent to which some important consuming regions depend for their timber supplies upon other regions is not always fully appreciated. Figure 20 illustrates this relationship between production

and consumption for lumber and other products of saw timber. It will be observed that the South and the Pacific Northwest are the two outstanding producing regions. Both produce far more than they consume. On the other hand, consumption in the other eastern regions exceeds production by a very wide margin. This is most notably so in the Middle Atlantic region.

In the earlier discussion on growth, it was pointed out that it does not appear feasible to sustain permanently the 1925–29 rate of drain,

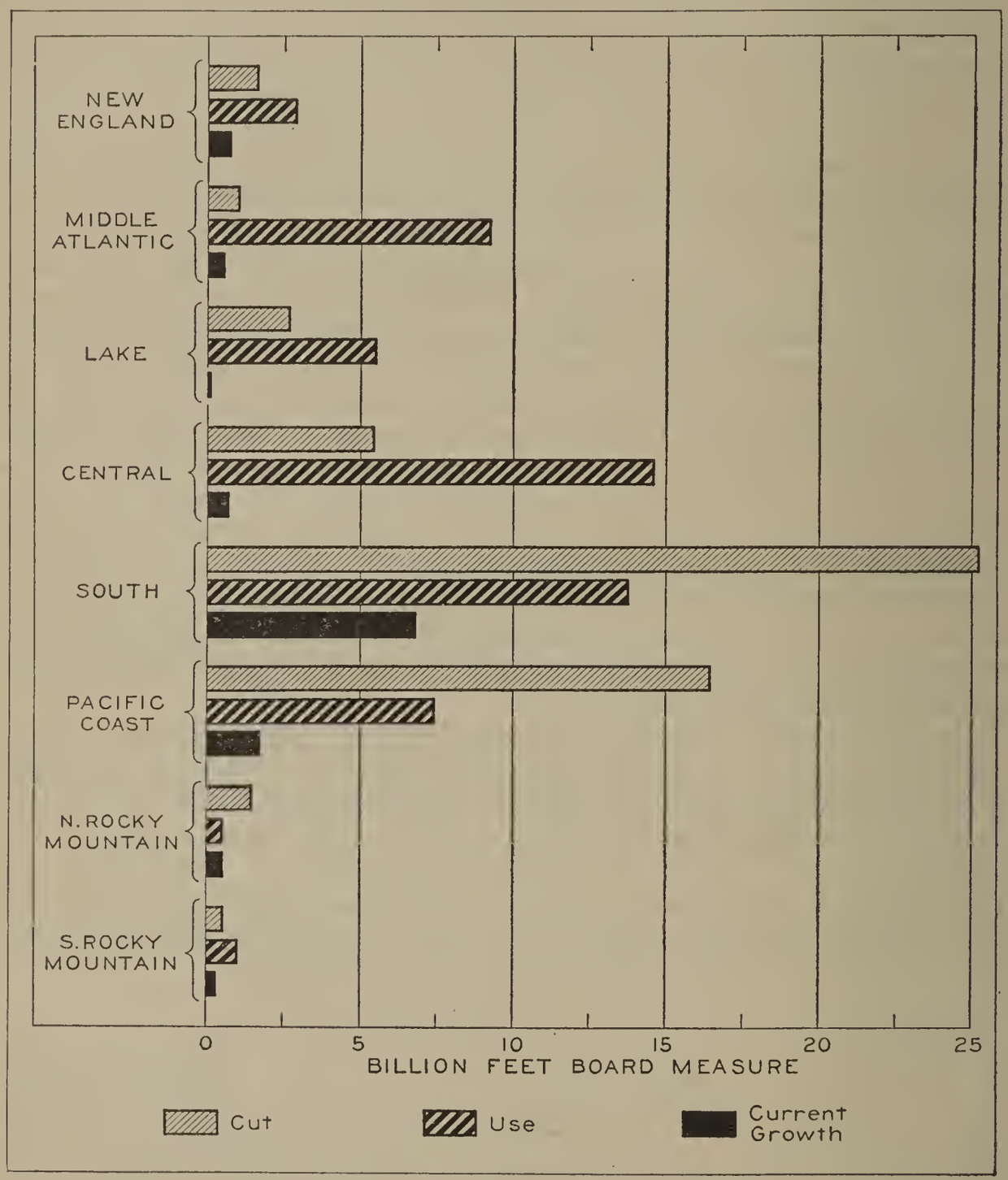

FIGURE 20.—Annual saw-timber cut, use, and current growth contrasted, by regions.

and even less to increase it in the four importing regions of the East. It is also shown that in the South, a considerable curtailment in the 1925–29 rate of drain appears to be inevitable in the not far distant future even in the absence of an economic depression. The North and South Rocky Mountain regions, though important locally, do not cut any great figure in the national situation as to timber supplies. If requirements are to continue on the basis outlined, the assurance of ample supplies for all regions during the next few decades appears to hinge largely upon the question of how far the Pacific Coast region

can go in making up the deficits in production in the four eastern regions as the exports to other regions from the South fall off. To say the least, it appears to present a very serious problem. It strongly suggests, from the long-range standpoint, the wisdom of far-reaching constructive measures for expanding supplies.

The corresponding relationships for all timber consumption and production, as measured in cubic feet, are shown in figure 21. The

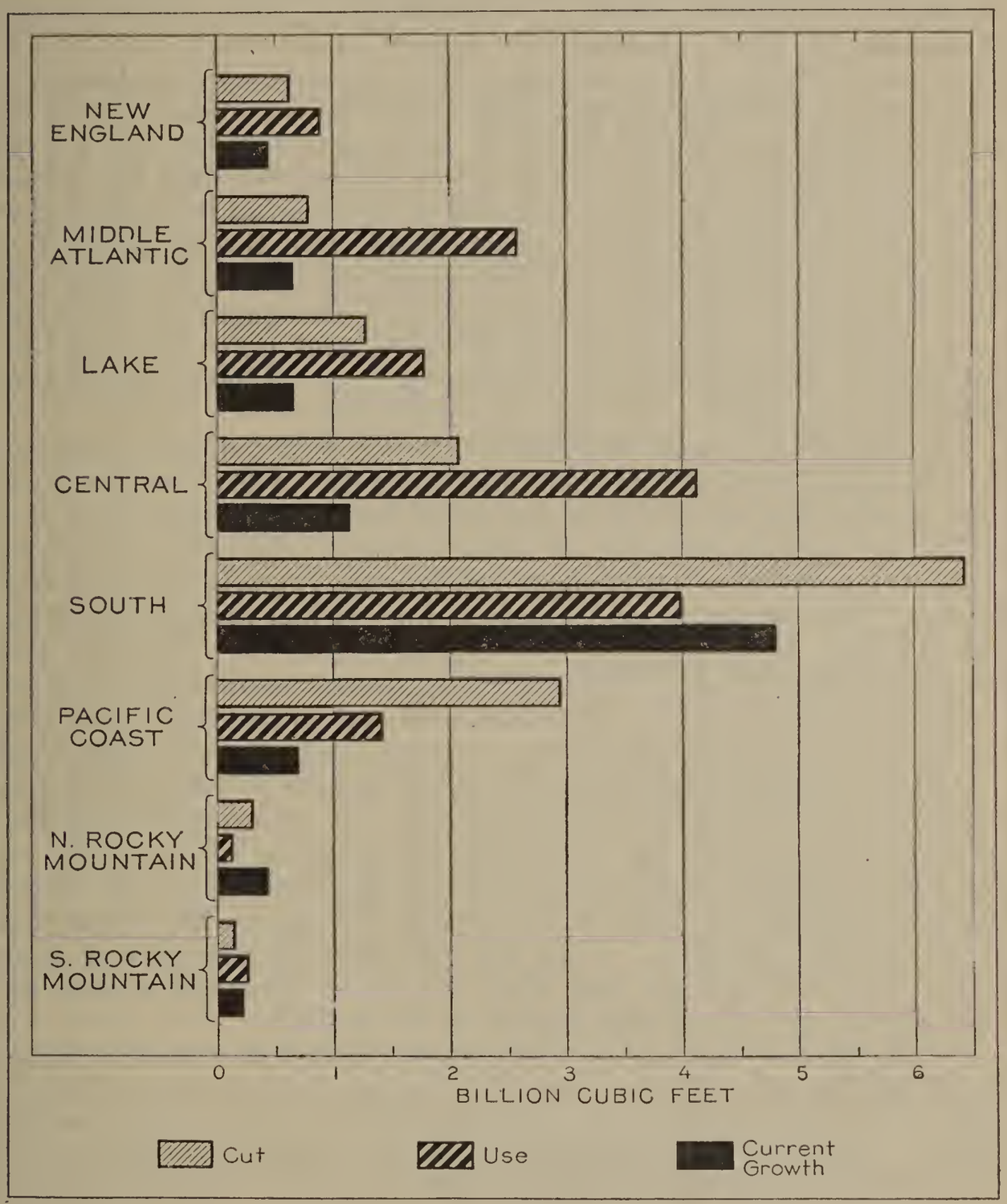

FIGURE 21.—Total annual timber cut, use, and current growth contrasted, by regions.

contrasts, though not so striking, because of the larger degree of regional independence so far as fuel wood and other minor products are concerned, is still just as significant in principle.

It is worth mention that the existing degree of interregional dependence is the reason for a volume of commerce which is of considerable importance to the railroads and other transportation agencies. Figures 20 and 21 also show the growth for the several regions in relation to production and consumption. The significance of these growth relationships is brought out in the preceding discussion under growth.

RELATION OF FOREIGN SUPPLIES AND MARKETS

Up to 1914 the trend of timber consumption was gradually upward in most of the important timber-consuming countries outside of the United States. (See following section, "Trends in World Wood Consumption".) Requirements for fuel wood tended to decrease, requirements for saw timber, and especially for pulpwood, to increase. When normal activities were resumed after the World War, the same tendencies continued until the beginning of the general economic depression in 1929. Russia, the largest consuming country except the United States and at the same time the possessor of the greatest forest resource, had not yet reached the pre-war consumption level, but her output of timber has been increasing rapidly and her plans call for a large increase in consumption during the next few years, as industrialization proceeds. Outside of Europe and North America, very few countries are yet industralized, but the trend is in that direction in many of them. Industrialization has always been accompanied by an increase in timber consumption—particularly of timber for construction, secondary manufacture, and pulp. Softwoods are preferred to hardwoods for a majority of uses. This preference seems likely to continue if softwoods are available.

The world's softwood supplies are being depleted. The importing countries and most of the exporting countries of Europe can increase their production very little or not at all, because they are now cutting up to the growth capacity of their forests. The only possible important sources of export supply are Russia, Canada, and the United States. The depletion of Canadian forests has already gone so far that no great increase in exports can be looked for. Russian forests have also been seriously depleted during recent years, and the quantity of timber economically available is believed to be insufficient to meet Russia's own requirements if the country develops according to plan.

It is doubtful whether Russian timber exports will maintain permanently a level as high as her pre-war exports. If supplies from Russia are cut off or reduced, as seems likely to happen within a few years, importing countries will have to turn to other sources. The southern pine and Douglas fir regions of the United States are the logical places to obtain these supplies. They are strategically located with respect to water transportation, and they can grow softwood timber faster than almost any other large region in the world.

About one fourth of our timber consumption is hardwood. Tropical hardwoods, particularly for special purposes, are now contributing to a degree to this requirement, and they may be more of a factor in the future. To place great reliance upon this source of supply would, however, be to overlook certain definite obstacles. The tropical forests in many regions have been depleted by centuries of misuse, burning, and cutting, so that present stands are composed mostly of comparatively worthless trees. The extensive areas of relatively good stands are characteristically composed of many species, only a few of which have as yet become merchantable. Much study will be required to determine the properties and uses, as well as suitable methods of manufacture, for many of the most plentiful species.

In brief, the indications are strongly that the United States can rely permanently upon foreign sources in no important degree for timber supplies. Beyond this there exists a situation of world consumption of softwood in excess of growth. This cannot continue

indefinitely and still permit the world's increasing softwood requirements to be met. Some students of the situation believe that world markets for softwoods will be such that they could consume several billion cubic feet of United States softwood supplies annually if cheaply and abundantly available. The significance of this is that our requirements for domestic consumption should not be the sole measure of the markets for United States forest products. The possibility of greatly increased exports should enter into the consideration of a program of constructive use of the Nation's forest lands.

A PLAN OF FOREST LAND MANAGEMENT CONSISTENT WITH NORMAL REQUIREMENTS FOR TIMBER

It has been estimated (see section "Forest Land the Basic Resource") that after allowing for withdrawals of forest land mainly for recreation, there is available for permanent timber use some 508.6 million acres of land. This includes commercial forest land and open land not needed for agriculture but which, so far as soil and other natural conditions are concerned, would be suited to timber growing.

How much of this available land, if it were under management for timber production, would afford a sustained yield on saw-timber rotations consistent with normal requirements? This will depend, of course, upon the type, or rather, types of management imposed. It does not seem economically practical to assume that a unified, blanket intensity of management could be spread over all of the land available for timber use. A combination of intensive forestry, extensive forestry, and simple protection, as defined in the preceding discussion of Timber Growth, is believed to be more logical. Such a combination affords a wide range in estimated sustained yield through the possibility of varying the acreages allotted to the several types of management.

Three examples of theoretical combinations of management will illustrate the wide range of results that may be obtained. (Table 25.) The first is referred to for convenience as plan I. This, although believed to represent a situation somewhat more favorable than that which now exists, may be thought of as involving the minimum in the way of a national program of forestry. It is what might possibly result from putting forest fire protection on a satisfactory basis, making a large curtailment in the overcutting in the eastern regions, and expanding somewhat the areas now under intensive and extensive forestry. It appears that this plan would develop a sustained yield of between 10.5 and 11 billion cubic feet. This is 20 to 25 percent more than the estimated present current growth, but far less than either the 1925-29 drain rate or our estimate of normal reqirements.

TABLE 25.—*Comparative plans for intensity of management of available forest land*

Management unit	Area	Growth rate	Total annual yield
	Acres	*Cubic feet per acre*	*Cubic feet*
PLAN I			
Intensive forestry	10, 000, 000	66. 7	670, 000, 000
Extensive forestry	100, 000, 000	42. 1	4, 210, 000, 000
Protected relatively favorable for forestry	254, 100, 000	20. 6	5, 230, 000, 000
Protected relatively unfavorable for forestry	69, 700, 000	7. 3	510, 000, 000
Open	74, 800, 000		
Total	508, 600, 000		10, 620, 000, 000
PLAN II			
Intensive forestry	100, 000, 000	66. 7	6, 670, 000, 000
Extensive forestry	338, 900, 000	42. 1	14, 270, 000, 000
Protected relatively unfavorable for forestry	69, 700, 000	7. 3	510, 000, 000
Total	508, 600, 000		21, 450, 000, 000
PLAN III			
Intensive forestry	70, 000, 000	66. 7	4, 670, 000, 000
Extensive forestry	278, 900, 000	42. 1	11, 740, 000, 000
Protected relatively favorable for forestry	40, 700, 000	20. 6	840, 000, 000
Protected relatively unfavorable for forestry	69, 700, 000	7. 3	510, 000, 000
Open	49, 300, 000		
Total	508, 600, 000		17, 760, 000, 000

Plan II envisions an extremely far-reaching application of intensive and extensive forestry. It may be considered as an ideal which would use for forestry all of the land estimated to be now available for that use, and would also leave a comfortable margin for a large ultimate increase in export trade or for other reasons above our estimate of normal timber requirements. It would also afford the maximum in the way of protection benefits and other nontimber uses.

Plans I and II, at opposite extremes, will serve in some measure to give a perspective to the timber-producing potentialities of our available forest lands. Any student of the forest situation may interpolate within this broad range such combination of areas allotted to different types of management as he may deem consistent with timber requirements, with the advantages of using for forestry all of the land now available for it, and with other factors.

Plan III, which is the combination presented in detail in tables 22 and 23, is offered as a working basis for the formulation of a Nation-wide program of forest-land use and forestry action consistent with our estimate of normal timber requirements. Timber requirements, rather than the use for forestry of all land available for it, is made the controlling consideration. It does, however, visualize a very great advance over the present situation, not only as to the amount of sustained timber yield assured, but also in the acreage of land devoted to forestry. It would mean, for example, the planting of some 25 million acres of land, or 13 times the amount estimated to have been planted by all agencies up to this time. If fully effected, say, by the close of the century, it would involve an annual increase of about a million acres in area under intensive forestry. It would mean a very great expansion of the area under extensive forestry. It would include what might be termed satisfactory fire protection on the total area in table 25, and a reduction in losses from disease, insects, etc.

It is believed that, from the standpoint of timber requirements, a sustained annual yield of 17¾ billion cubic feet, such as this plan for

forest land use contemplates, is a sound, conservative objective for the following reasons:

(1) Our estimate of normal requirements is 16.5 billion cubic feet. A national program of forestry should be based upon a sustained yield of at least a billion cubic feet more than this as a margin for safety.

(2) Beyond the estimated normal requirement of 16.5 billion cubic feet is the ultimate probability that the United States may supply the world softwood markets on a much larger scale than hitherto.

(3) Such a far-reaching and drastic program as that embodied in this tentative set-up can hardly be expected to be brought to the point of complete accomplishment. For example, short of sweeping public regulation of privately owned forest lands and a large program of further public acquisition, there is no means of insuring the practice of forestry on anything like the acreage of forest lands involved in this plan.

A very long time will be required, probably 60 to 80 years at least, before anything approaching full accomplishment under plan II or plan III can be realized. Moreover, the realization of such a plan involves several major features, probably not all of which can be carried forward at once with full speed. It is, therefore, fitting to inquire what single feature deserves first consideration as measured by its effect upon bringing sustained timber yield into balance with requirements as promptly as possible.

The most unsatisfactory aspect of our present forest situation, from the standpoint of timber use, is believed to be the tremendous impoverishment of the growing stocks in the eastern regions. It is one that has in the past had relatively little general recognition. By and large, cutting has been at the expense of capital account. A situation has been reached in these eastern regions where, according to the estimates presented under the heading Sustained Yield Possibilities in the preceding discussion of Timber Growth, regulated growing stocks equivalent to the volume of present stands would support, under saw timber rotations, a sustained yield equal only to about two fifths of that which is called for by plan III.

Generally speaking, a forest property upon which stands are already established, even though inadequately, can be developed into a regulated sustained yield enterprise at less expense and more quickly than one upon which established stands are largely lacking. The relative importance of taking every advantage of the existing stands in the East as the main basis for attaining a satisfactory growing stock situation is, therefore, obvious.

In the opinion of the authors the safeguarding of existing stands in the East and their development into adequate growing stock is the most urgently needed constructive measure. This fact does not, however, minimize the necessity of providing for an adequate planting program for areas not likely to restock naturally, for the development of adequate protection against fire, insects and disease, and for the control of cutting in the western regions, to facilitate the conversion of those forests to an adequate sustained yield basis. All of these features are essential elements in the realization of either plan II or plan III.

Recent trends in growth and drain on our forest resources, if continued, will further aggravate an already very unsatisfactory condition. Although we appear to have a potential forest land resource,

extensive enough to meet the nation's forest requirements, it will be necessary, in order to meet such requirements, to effect a very great extension in the practice of forestry and in measures to build up the forest growing stock, and to protect and maintain this growing stock on a sustained yield basis. In addition to the desirability of assuring adequately that the requirements of the United States for timber products and other forest uses and services will be met, we have the economic incentive for making constructive use of a huge area of forest land which by and large is not susceptible of any other major commercial use.